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ABSTRACT

Phase II of the Iowa High School Industrial Arts project sought to revise industrial arts content to include the infusion of new technologies, structured mathematics and science content, and a less project-oriented approach to teaching. The project identified a philosophical basis and a content structure; set priorities for development and delivery of content; identified and prepared delivery vehicles; and evaluated the vehicles, the philosophical basis, and the content structure. During the first year of Phase II, the philosophical basis, the content structure, and the content priorities were generated; the other areas will be worked on during the next two years. The products chosen were a group of modules representing each of the major content areas and a curriculum guide designed to communicate the philosophical basis and the content structure. This document contains the project report and extensive appendixes that contain lists of planning members, fall conference and meeting reports, evaluation procedures, a project personnel chart, a sample of a test item bank, a list of workshop participants, and three modules. These modules, which make up a large part of the document, cover graphic communications, energy and power, and manufacturing. Each module consists of a rationale, objectives, sources of information, and detailed lesson plans for each unit. (KC)

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REPORT ON YEAR ONE OF PHASE II

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A CURRICULUM DEVELOPMENT EFFORT

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TABLE OF CONTENTS

ITEM PAGE

I INTRODUCTION 1

Current Condition of High School Industrial Arts. . 1

Goals 2

Methodology 2

II PROJECT OBJECTIVES 4

81-88 Phase I Objectives. 4

Phase II - Year One Objectives. 5

83-89

Year One Objectives - Primary. 5

Year One Objectives - Secondary. 5

Year Two & Three Objectives 6

Year Two Objectives - Primary. 6

Year Two Objectives - Secondary. 6

Year Three Objectives - Primary. 6

Year Three Objectives - Secondary. 7

Reactions to the Phase I Report 7

A Plan for Articulation Between Junior High and High School 8

III YEAR ONE METHODOLOGY & RESULTS 10

Selection of the Curriculum Advisory Panel. 10

Curriculum Delivery Systems 11

Evaluation Model. 16

Workshops 16

Item Bank Preparation 17

IV YEAR TWO ACTIVITIES. 19

Objectives. 19

TABLE OF CONTENTS (continued)

ITEM PAGE

Procedures 19

- Pilot Testing 20
- Module Revision 20
- Training for Field Testing. 21
- Curriculum Guide Format and Content 21
- Preparation of a Curriculum Guide 21
- Workshops 22

Year Two Time Line 22

V YEAR THREE ACTIVITIES 24

VI SUMMARY 25

REFERENCES 26

APPENDICES

- APPENDIX A: Curriculum Advisory Panel Members
- APPENDIX B: Planning Committee Members
- APPENDIX C: Fall Conference Report
- APPENDIX D: Summary of April 6, 1984 Curriculum Advisory Panel Meeting
- APPENDIX E: Evaluation Procedures
- APPENDIX F: Graphic Communications Module
- APPENDIX G: Energy & Power Module
- APPENDIX H: Manufacturing Module
- APPENDIX I: Project Personnel Chart
- APPENDIX J: Sample of Test Item Bank
- APPENDIX K: Workshop Participants

I. INTRODUCTION

The Iowa High School Industrial Arts Project was initiated to effect curriculum improvement in the secondary industrial arts programs in the state of Iowa. The project was conceived by the Iowa Industrial Arts Cadre and the Iowa Department of Public Instruction and represents an attempt to help high school industrial arts programs adjust to the current and future needs of students enrolled in these programs.

The project is divided into two phases. Phase I determined the status of industrial arts in Iowa and examined other research development efforts that have occurred or are occuring across the country. This phase was completed during the 1981-82 school year. Phase II represents a conceptualization, development, and evaluation effort aimed at producing curriculum materials that can be used in industrial arts classrooms and a curriculum guide for structuring new programs and changes in existing programs. Phase I was one year in length and Phase II is currently in the second year of a planned three-year effort.

Current Condition of High School Industrial Arts

Public education has been the subject of many critical reports in the past few years. Vocational education, in particular, has been the object of much of the criticism. State legislatures are feeling the need to mandate changes in public schools in order to rectify perceived needs. Vocational funding, in which industrial arts enjoys a share, has been threatened from many fronts. The emphasis during the early 1980's appears to be in math and science and other "academic" subjects.

The results from Phase I and the Industrial Arts Standards Project suggests that industrial arts has changed little in the past thirty years.

Drafting, woodworking, metal working, and crafts still appear to be dominating the industrial arts curriculum scene. It has become increasingly difficult to justify these more traditional industrial arts curriculum areas in the eyes of administrators, parents, and a concerned public.

In Iowa, along with other parts of the nation, the emphasis is also on "high technology" along with the emphasis on "academics". The time appears to be ideal for curriculum development activities such as the Iowa High School Indsutrial Arts Curriculum Project.

Goals

To achieve superior industrial arts programs in the high schools of Iowa requires (a) a carefully conceived and documented philosophical basis for new curriculum; (b) broad based participation of high school industrial arts teachers in the development of the new curriculum; (c) thorough testing and evaluation of the new materials, outlines, procedures, methods; (d) packaging the materials in an attractive, convenient manner; and (e) dissemination through cost effective training programs. This project proposes to accomplish these goals over a three year period. It builds upon the results of Phase I which described the current status of industrial arts, prioritized new curriculum development needs, and recommended new philosophical directions and dimensions for high school industrial arts. In addition, special attention needs to be given to the earlier exploratory industrial arts guide for purposes of articulation.

Methodology

The conceptualization step in this project began with a literature review to determine what curriculum development efforts could be useful to guide this effort. Input from teachers, guidance counselors, administrators, industry personnel, university personnel, and the Department of Public Instruction was solicited. Provisions were made for interaction between all groups.

Conceptualization included the development of philosophical basis to guide subsequent curriculum development efforts, development of a content structure to guide articulated course and unit content, and the development of the vehicle designed to deliver the materials. Additionally, teaching methods were identified which proved to be useful as a guide during the developmental phase of the project.

The development portion of this effort included teachers from high school and junior high industrial arts programs, teachers from other areas, along with input from administration, industry, and university personnel. The development will include pilot testing the materials conceived and prepared by the teachers during year one and subsequent revision to adjust concerns discovered during testing. The resulting materials will be attractively packaged and made available to the widest possible audience for implementation.

The evaluation step involves engaging an external evaluator who will guide every phase of the evaluation. Instruments will be developed which measure the knowledge of relevant content. Analyses will be performed that provide information for use by decisionmakers when considering the adoption or adaptation of project materials.

II. PROJECT OBJECTIVES

In order that a complete overview be provided, this chapter is divided into three sections. The first covers those objectives addressed during Phase I of the project. The second section covers those objectives proposed and completed during year one of Phase II of the project, and the third section covers those objectives to be addressed during year two and three of Phase II.

Phase I Objectives

Phase I was considered the research phase and was completed during the 1981-82 school year. The following objectives were addressed: (1) completion of a comprehensive review of courses, course units, topics, concepts, skills, and attitudes currently taught and considered desirable to teach in high school (secondary) industrial arts programs; (2) the identification and description of underlying common dimensions within the content of existing and desired industrial arts programs that may form a theoretical basis for future comprehensive high school industrial arts programs; (3) the prioritization of topics, content, skills, and attitudes for subsequent development of instructional modules and materials; (4) the description of goals, objectives and conceptual dimensions or framework for the high school industrial arts curriculum consistent with the Iowa Guide for Curriculum Improvement in Industrial Arts, K-12; (5) the development and description of criteria which may be used in the subsequent development of instructional modules appropriate to the high school industrial arts curriculum; (6) the dissemination of descriptions of current industrial arts programs found to best exemplify the goals, objectives, content, and instruction desired in the high school industrial arts curriculum.

Phase II - Year One Objectives

The objectives addressed during year one of Phase II of the High School Industrial Arts Project can be divided into two groups. The first group consists of those objectives that were identified by the original proposal. The second consists of those objectives that were by-products of developments and work done while addressing the primary objectives.

Year One Objectives - Primary

The following were identified on the proposal.

1. Establish a steering committee composed of an industrial arts Curriculum Advisory Panel (CAP) to provide direction, consultation, reaction, and evaluation of activities for Phase II;
2. Obtain reactions and input from Iowa industrial arts teachers to the recommendations and results of the Phase I report;
3. Develop a plan for articulation between entry level industrial arts and high school industrial arts and lower schools;
4. ~~Develop a plan to establish a curriculum structure delivery system which reflects input from the National Standards for Industrial Arts;~~
5. Identify parameters to utilize in an evaluation model for evaluating a curriculum structure, content, delivery, and personnel of high school industrial arts programs;
6. Conduct workshops for developing materials, evaluation procedures, and delivery systems.

Year One Objectives - Secondary

1. Creation of an item bank which can be utilized by high school teachers to create tests in any industrial arts content area;

2. Creation of a library of resources and computer programs for use by Iowa industrial arts teachers.

Year Two & Three Objectives

The year two and three objectives have been divided into primary and secondary objectives similar to the previous section. These objectives will be accomplished during the 1984-85 and 1985-86 school years.

Year Two Objectives - Primary

1. Pilot test initially developed materials, evaluation procedures and delivery strategies.
2. Revise materials, methods, and strategies based on pilot tests.
3. Train personnel to conduct field testing of materials, methods, and strategies.

Year Two Objectives - Secondary

1. Prepare a curriculum guide in the form of a handbook to communicate the structure and philosophical basis generated during previous project activities.
2. Prepare an objective general industrial arts test that can be used during the year three evaluation.

Year Three Objectives - Primary

1. Conduct field testing of revised curriculum materials, evaluation procedures and the delivery systems.
2. Provide camera-ready copy of materials, tests, media descriptions, and other instructional materials for subsequent distribution throughout Iowa. Also provide master sets of computer disks, video tapes, films, and other non-printed material.

3. Provide a comprehensive summary and evaluation of the three year project.
4. Conduct in-service sessions aimed at disseminating products, curricula, evaluation strategies, and results of the Phase II project. The fifteen AEA's in the state will be utilized as sites for these dissemination sessions.
5. Recommend future implementation and dissemination strategies to utilize in subsequent years.

Year Three Objectives - Secondary

1. Obtain reactions to the curriculum guide generated during year two of Phase II. Reactions will be obtained from administrators and teachers and university personnel from all geographical areas of Iowa.
2. Provide a high quality reproduction of the curriculum guide for all interested parties.

Reactions to the Phase I Report

Reactions to the Phase I Report were obtained from industrial arts teachers around Iowa at the two major conferences conducted during the 1983-84 school year. The first was the Fall conference in Waterloo and these reactions were obtained during a presentation made by Bill Miller and John Dugger, and the second group of reactions were obtained during the Spring conference at Iowa State University and these forms were passed out during several of the conference presentations.

The results suggest that the structures and recommendations identified during Phase I of the project were met with approval by the industrial arts teachers. Almost all felt that changes had been slow in coming in the field of industrial arts. Research supports the notion that in the past thirty years very few changes, if any, have occurred in the industrial arts labs and classrooms. Also agreed upon was a perceived need for an infusion of high technology into existing industrial arts classes. In addition, the majority support more joint ventures involving math, science, and industrial arts departments.

In summary, the majority of the industrial arts teachers in Iowa agree with the Phase I recommendations. The area in which teachers appeared not to agree was in the identification of a methodology that could be used to generate new content and new materials for dissemination to industrial arts programs in Iowa. This is one of the primary objectives of Phase II of the project.

A Plan for Articulation Between Junior High and High School

The Curriculum Advisory Panel along with the Iowa High School Industrial Arts Cadre, the Department of Public Instruction, and the Project Staff identified a Planning Committee which had as it's major objective to determine a philosophical basis and a content structure for Iowa high school industrial arts. The Planning Committee membership included twenty-four names which was an expanded version of the Curriculum Advisory Panel. This larger group was more representative of Iowa teachers and administrators than the Curriculum Advisory Panel.

The Planning Committee meeting was held during the Fall Iowa Industrial Education Conference. Prior to this meeting all committee members received summaries and reports from other curriculum development efforts. Those included the Jackson's Mill Plan, the American Industrial Arts Curriculum Project, the Maryland Plan, the American Industry Project, and the more recent Illinois Plan. The Planning Committee members also received copies of the Phase I report.

The meeting consisted of presentations on those important curriculum development efforts and proposed methodologies for achieving the objectives of generating a philosophical basis and a content structure. Of major concern was the need to articulate with the existing exploratory industrial arts program with the high school curriculum to be developed.

The results of this Planning Committee meeting are included in Appendix C. A philosophical basis for Iowa industrial arts appeared to be very similar to that described in the Jackson's Mill Plan. The most desirable methodologies appear to be similar to those described in the Maryland Plan. The content structure identified included portions described by the Industrial Arts Curriculum Project and parts of the structure identified by the Iowa Guide for Curriculum Improvement in Industrial Arts, K-12.

A consensus was obtained regarding headings that should be used to describe major content areas. Those identified include manufacturing, construction, graphic communications, energy and power, and transportaion. These content headings were identical to those recommended in Phase I. The committee felt that a need for articulation and a need for introduction of new content could best be addressed by headings such as the ones mentioned above. The need to provide some flexibility was also recognized and the Curriculum Advisory Panel was empowered to make necessary changes as deemed appropriate to the guidelines and recommendations put forth by the Planning Committee.

III. YEAR ONE METHODOLOGY & RESULTS

This section describes the methodologies and the results obtained while addressing the year one objectives. Four groups were utilized in the accomplishment of the objectives. They included the Project Staff, the Curriculum Advisory Panel, the Planning Committee and the Workshop Participants. Subsequent sections describe how these groups were selected and utilized in the accomplishment of the objectives.

Selection of the Curriculum Advisory Panel

Once the project had been initiated by establishing the proper accounts, identifying the graduate assistants and the project secretary, the Curriculum Advisory Panel was selected. Input from the Iowa Industrial Arts Cadre and the Iowa Department of Public Instruction was solicited and the list of those contacted included administrators in both vocational and secondary education, high school industrial arts teachers, people from science education, and junior high industrial arts teachers. The names of those people chosen are located in Appendix A.

Those individuals selected were first contacted by phone and then by letter with carbon copies to their principal and superintendent or immediate supervisor. A profile sheet was generated for each Curriculum Advisory Panel member indicating education attained, interests, work address, home address, social security number, and phone numbers.

The first official advisory panel meeting was held during the Iowa Curriculum and Instruction Conference on the campus of Iowa State University on October 21, 1983. Prior to this meeting, copies of summaries of previous and on-going industrial arts curriculum development efforts were sent to the Curriculum Advisory Panel. During this meeting the project objectives, the role of the panel, and the purpose of the upcoming Planning Committee meeting were explained. The panel members were asked to assume a leadership role during the Planning Committee meeting.

Curriculum Delivery Systems

Curriculum development projects in industrial arts, such as Jackson's Mill, the American Industry Project, the Maryland Plan, the Industrial Arts Curriculum Project in most cases assumed that courses would be the vehicle of delivery.

Discussions in the fall Planning Committee meeting and the subsequent Curriculum Advisory Panel meetings suggested that an outline or course description with objectives is not enough.

The perceived needs for industrial arts programs were a lack of high technology content, a lack of coordinated science and math content, and a methodology that overemphasized the use of the project. A curriculum delivery system would ideally be able to deal with these three major problems.

The system that appeared to have the most promise was the module approach. Modules of instruction, preferably no more than 5 or 6 weeks, would be prepared and include daily lesson plans and minute-by-minute instruction. The detailed lesson plan would address the problems of methodology, the content problem could also be addressed using the module approach.

Based on the expected funding for the next two years of the project, the module approach was chosen as the vehicle. Additional funds may have made it possible to conceptualize and produce complete courses, but those would be more difficult to implement due to the diversity in facilities and expertise of the instructors. Therefore, modules were chosen as the vehicle to deliver the methodology and new content.

The content structure received constant attention throughout year one. At each Curriculum Advisory Panel meeting at least a share of the time was devoted to dealing with the problem of content structure. The five clusters or divisions of content decided upon during the Planning Committee meetings in the fall were only a step in the development of a comprehensive content structure. The most recent development occurred during May, 1984 Curriculum Advisory Planning meeting. During this meeting content matrices were prepared for graphic communications, manufacturing, and energy and power. The panel attempted to discover the fundamental content elements that should be covered in all industrial arts courses and units in these cluster areas. These areas were selected for immediate attention since the upcoming workshops were committed to developing modules in each of those three clusters.

Figure 1, 2, and 3 display the matrices developed by the Curriculum Advisory Panel. The concept dimensions are very similar while other dimensions differ significantly due to the nature of the particular content.

GRAPHIC COMMUNICATIONS MATRIX

	General Graphic Communication Steps					
	Input	Process				Output
Concepts	Image Design	Image Generation	Image Conversion	Image Preparation	Image Transfer	Finishing/ Distribut.
Materials	1	1	1	1	1	1
Sub-Systems - Inputs Processes - Outputs	1	1,2	1,2	1,2	1,2	1,2
Technical Terms & Symbol	1,2	1,2	1,2	1,2	1,2	1,2
Safety	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Measurement & Quality Standards	1	2	2	2	2	2
Historical Perspective	1,2	1,2	1	1	1	1
Social, Psychological & Ecological Impact	2,3	2,3	2,3	2,3	2,3	2,3
Managerial & Organizational Practices/ Enterprise	2,3	2,3	2,3	2,3	2,3	2,3
Careers	1	1	1	1	1	1
Computer Applications	2,3	2	2	2	3	3
Research & Development	3	3	3	3	3	3
Tools	2,3	2,3	2,3	2,3	2,3	2,3
Scientific Principles	1,2	1,2	1,2	1,2	1,2	1,2

FIGURE 1: GRAPHIC COMMUNICATIONS MATRIX

Manufacturing

Level 9-12

TENTATIVE ORGANIZATION STRUCTURE

MANUFACTURING

CONCEPTS

System Organization:	Input	Processing		Output
Elements of:	Organization	Materials	Processes	Products
Measurement	M,L	S,M,L	S,M,L	M,L
Scientific Principles	M,L	S,M,L	S,M,L	
Systems	M,L		S,M,L	
Energy		M,L	M,L	
Materials		S,M,L	S,M,L	
Technology (Past, (Present, Future)	L	M,L	M,L	S,M,L
Social Psychological Impacts of Technology	L		M,L	
Ecological Effects	M,L	S,M,L	M,L	M,L
Careers	S,M,L		S,M,L	S,M,L
Safety	S,M,L	S,M,L	S,M,L	
Communications Theory	L		S,M,L	L
Industrial Organization	M,L	M,L	S,M,L	
High Technology		S,M,L	S,M,L	
Research & Development		S,M,L	S,M,L	M,L
Computer Applications	L	M,L	S,M,L	

S - Required for Small Size Program - Basic Program

M - Required for Medium Size Program - Intermediate Program

L - Required for Large Size Program - Total Program

FIGURE 2: MANUFACTURING MATRIX

ENERGY & POWER GRADES 9 - 12

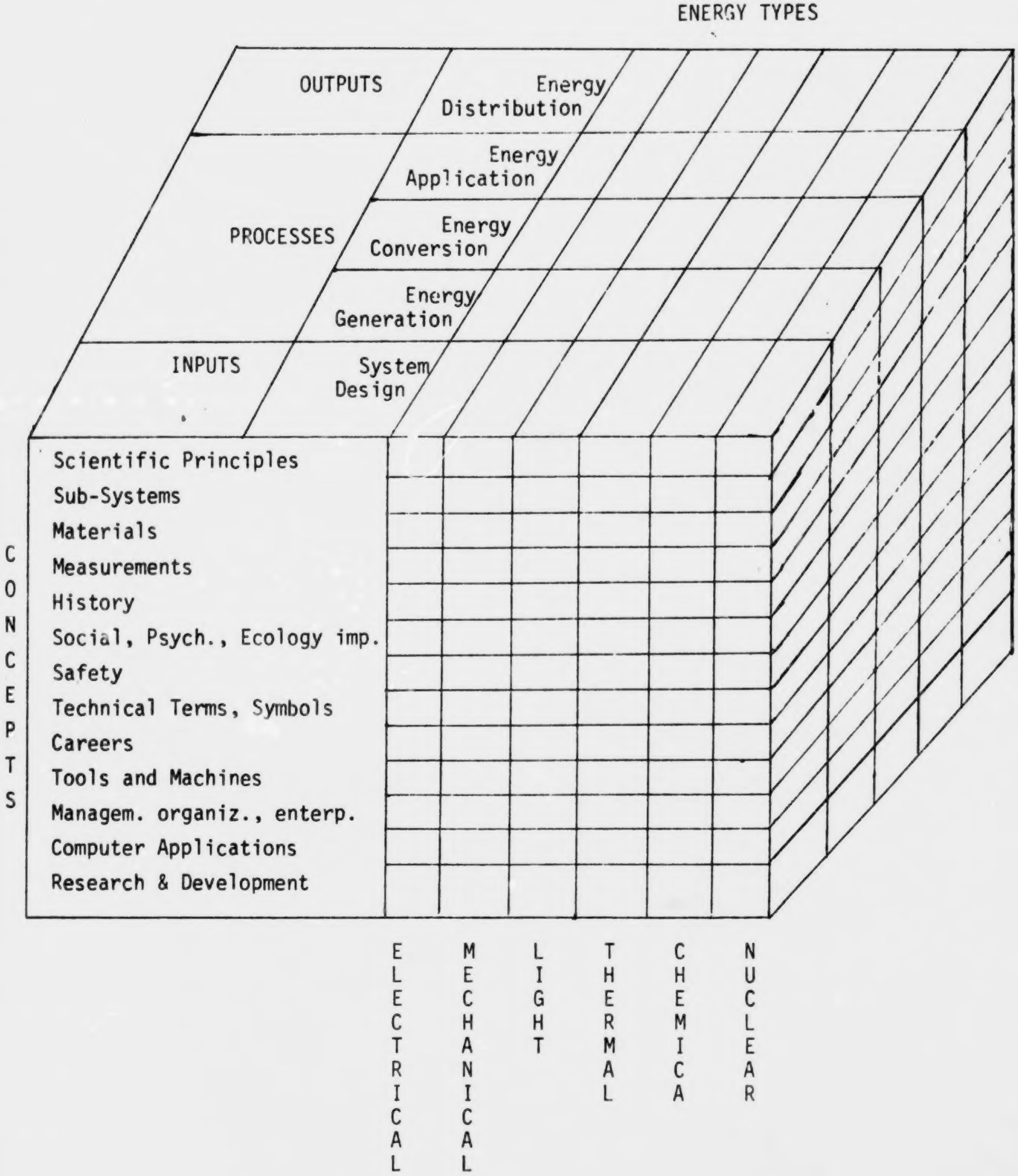

FIGURE 3: ENERGY & POWER MATRIX

The Curriculum Advisory Panel will continue to refine these matrices and create matrices for the construction and transportation clusters during year two. These matrices will provide a foundation for the development of the high school curriculum guide and future curriculum materials.

Evaluation Model

The evaluation model has been developed by the project staff and is included in Appendix E. This model describes the evaluation of the curriculum structure, the content, the delivery vehicle and the personnel involved in each of the phases. Statistical analyses and hypotheses are also identified.

Reactions to the evaluation plan were obtained from the members of the Curriculum Advisory Panel since several members have had extensive experience in research, design, and evaluation. This model will be used as a guide during the year three evaluation.

Workshops

The curriculum development workshops were conducted at Hoover High School in Des Moines and at Iowa State University. The workshops focused on graphic communications, manufacturing, and energy and power. The instructors for the workshops were Bob Gelina, Bill Miller and John Dugger from Iowa State Univeristy. The workshop participants (Appendix K) included fourteen industrial arts and science teachers from both large and small school districts in Iowa.

The workshops were four weeks in length with the first week devoted to orientation activities where presentations on earlier Curriculum Advisory Panel activities were given and field trips to local industries were conducted. The last three weeks were spent developing the modules for each of the three clusters.

Workshop activities included developing daily lesson plans with supporting materials such as transparencies, slides, video tapes, and reading material. It was felt that the resulting modules could be implemented with a minimum of effort and expense by the teacher and school district. The lesson plans and parts of the modules are included in Appendices F, G, and H.

These materials will be pilot tested during the 1984-85 school year. Pilot test sites will be selected with a minimum of five sites utilized for the testing of each module. Large, medium, and small school districts will also be selected as sites for the testing of each module.

Item Bank Preparation

One of the by-products of this project is an item bank containing questions for all industrial arts subject areas in both junior and senior high schools. Early during the first year, it was determined that several objective tests would be needed for the evaluation phase of this project. In addition, it was determined that the best method for storing and retrieving these items would be utilizing one of the computers on the ISU campus.

The computer chosen was the AS-6 and the software selected was the SPIRES program. This program allows for the classification of each question by several different levels. One level was by cluster area, another level was by traditional industrial arts course title. Such a classification system would allow easy access by teachers throughout the state to the items.

This item bank was a secondary objective not identified on the proposal. Its creation, however, appears to be very valuable for both the project and teachers in Iowa. A sample of the test items included in the item bank can be found in Appendix J.

IV. YEAR TWO ACTIVITIES

The activities during year two will center around the development of materials that can be used in the industrial arts classrooms and programs to guide the identification of content, methodology, and courses. The objectives, procedures, and the time line will be described in this section.

Objectives

The following are major objectives to be addressed during year two of Phase II of the Iowa High School Industrial Arts Project.

1. Pilot test initially developed materials, evaluation procedures, and delivery systems.
2. Revise the materials, evaluation procedures, and delivery systems based on the results of the pilot testing.
3. Train personnel to conduct field testing (year three) of materials, methods, and strategies.
4. Determine the format and content of the curriculum guide for Iowa high school industrial arts programs.
5. Prepare a curriculum guide for Iowa high school industrial arts programs that reflects the philosophical basis and content structure identified.
6. Conduct workshops aimed at the development of additional materials, evaluation procedures, and delivery vehicles.

Procedures

The personnel that will be utilized to accomplish the year two objectives include an expanded Curriculum Advisory Panel, a Curriculum Guide Committee, the Iowa Industrial Arts Cadre, Workshop Participants, and the Project Staff. All activities will be coordinated by the Curriculum

Advisory Panel and the project staff. A description of the activities aimed at achieving the year two objectives are provided in subsequent sections.

Pilot Testing

A minimum of fifteen sites will be selected for the pilot testing of the three modules developed during the summer of 1984. All reasonable attempts will be made to provide an equal number of sites for the testing of each module.

Workshop participants will be given the opportunity to pilot test modules developed in their particular workshop. Other sites will be selected based on interest, facilities available, and personnel. Both large and small school districts will be selected as test sites for each module.

A pre-test and a post-test is included within each module. The data will be collected and analyzed by the project staff. Evaluation forms, designed to gather the perceptions of the pilot test teachers regarding the effectiveness of each portion of the module, will be administered on site at the end of the module. In addition, an evaluation meeting attended by the project staff and each of the pilot test site teachers will occur as soon after the completion of the module as possible.

As an incentive for the prospective schools, $750 will be provided once a teacher and the administration agree to pilot test the materials. An additional $250 will be provided after the final evaluation of the module is complete.

Module Revision

The modules will be revised based on the results of the pilot test. Revision will begin during the evaluation meeting that includes the pilot test teachers and project staff. If additional revision is required, the Curriculum Advisory Panel will determine if this revision can occur during regular Curriculum Advisory Panel meetings or if revision should be performed during the 1985 summer workshops.

Revised modules will then be made camera-ready by the project staff and then reproduced. The objective will be to produce a professional quality module.

Training for Field Testing

The Curriculum Advisory Panel and project staff along with the help of an external evaluator will prepare training guidelines for prospective field test personnel to prepare for the third year evaluation. This guide will have as its objective to sensitize the field test cooperating teacher to the specific field testing needs.

Curriculum Guide Format and Content

The Curriculum Advisory Panel will determine the format and content of a proposed curriculum guide for use by high school industrial arts teachers. The purpose of this curriculum guide will be to guide the revision of existing courses and the creation of new courses.

A format and content that would be most useful to Iowa high school industrial arts teachers will be the primary objective. During the selection process, copies of other curriculum guides will be provided for the Curriculum Advisory Panel by the project.

Preparation of a Curriculum Guide

The Curriculum Advisory Panel will select a committee that will have as its objectives the preparation of the curriculum guide. During this preparation the Curriculum Advisory Panel will work closely with this committee to assure that the needs of Iowa industrial arts teachers are being met.

Once the rough draft of the curriculum guide has been prepared, copies will be provided to selected Iowa industrial arts teachers and administrators to obtain their reactions and input. The curriculum guide will then be revised by the committee to reflect this input. Camera-ready copy will be generated by the project staff. The guide will then be printed in sufficient quantities to be made available to Iowa industrial arts teachers and school administrators.

Workshops

The Curriculum Advisory Panel will identify the tasks to be performed during the 1985 summer workshops. These tasks may include the revision of modules prepared during the 1984 summer workshops and the creation of new modules in transportation and construction.

Year Two Time Line

The following time lines will be used as a guide for year two project activities.

YEAR TWO TIME LINE 1984-85

OBJECTIVES	DATES											
	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Project Initiation	XXXX	XXXX										
Selection of Pilot Test Sites	XXXX	XXXX										
Pilot Testing			XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX		
Revision of Modules				XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	
Selection & Training of Field Test Personnel								XXXX	XXXX	XXXX	XXXX	XXXX
Identify the Format & Content for the Curriculum Guide			XXXX	XXXX	XXXX	XXXX						
Preparation of the Curriculum Guide				XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX		
Conduct Workshops										XXXX	XXXX	XXXX
Prepare Year Two Report					XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

FIGURE 4: YEAR TWO TIME LINE

V. YEAR THREE ACTIVITIES

Year three activities will be focused on the evaluation of the materials that have been developed by the high school project. An independent evaluator will be chosen to guide this activity.

Any new modules developed during the 1985 summer workshops will also be pilot-tested in a manner similar to testing done during the 1984-85 school year. Revision and printing of the modules will occur during the early part of 1986.

The evaluation of the curriculum guide and those modules prepared during the 1984-85 school year will be the primary task during year three. An evaluation model is included in Appendix E.

VI. SUMMARY

Recent studies indicate that industrial arts content has changed very little during the past thirty years. Most observers feel that industrial arts courses and programs need modifications. Desirable modifications include the infusion of new technologies, structured math and science content, and a less project-oriented approach to teaching.

Phase II of the Iowa High School Industrial Arts project proposed to address these and other concerns. The procedure utilized by the project involved identifying a philosophical basis and a content structure, prioritizing content for development and delivery, identifying and preparing delivery vehicles, and evaluating the vehicles, the philosophical basis, and the content structure.

During the first year of Phase II, the philosophical basis, the content structure, and prioritized content were generated. Year two involves preparing the products, while year three is devoted to evaluating and disseminating these products.

The products chosen were a group of modules representing each of the major content areas and a curriculum guide designed to communicate the philosophical basis and the content structure. Development of three of the modules began during the latter-part of year one. Both the modules and the curriculum guide should be ready before the year three evaluation activities.

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APPENDIX A

CURRICULUM ADVISORY PANEL MEMBERS

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APPENDIX C

FALL CONFERENCE REPORT

Session I of the Planning Committee
Waterloo, Iowa - November 4-5, 1983
Summary

I. PURPOSE OF THE MEETING

The Planning Committee of the High School Industrial Arts Project met Thursday and Friday during the Iowa Industrial Education Association annual meeting in Waterloo, Iowa. The objectives of the meeting were to:

A. Identify a philosophy to serve as a basis of curriculum development at the high school level.

B. Identify topical areas or clusters of content to be included in the curriculum.

C. Identify, if appropriate, a name which appropriately describes the new philosophy and content.

D. Identify areas of agreement and disagreement concerning philosophy, content and delivery systems to address in later discussions.

The committee consisted of teachers, administrators, and educators with various backgrounds and a familiarity with Iowa educational practices. The committee was essentially an enlarged Curriculum Advisory Panel which was established to guide the activities of Phase II of the Iowa High School Industrial Arts Project.

II. METHODOLOGY EMPLOYED

Committee members were presented a series of short descriptions, both orally and written, of current and recent past philosophical approaches and conceptualizations of industrial arts curricula. In addition, four questionnaires were distributed to each participant to serve as worksheets for small group discussion of philosophy, content and delivery systems. Four groups ranging in number from 5 to 7 were formed among the participants for small group discussion. One member from each group served as a coordinator to summarize agreements and disagreements on issues raised in the worksheets. A summary of worksheet responses was then produced and discussion was held among the coordinators to further resolve differences.

During each group session, individual responses to worksheet items were recorded by the group coordinators. Pertinent discussion topics were also recorded and these were shared during the coordinator conflict resolution session. All individual and group worksheets were collected and tallied by the project staff and used in preparing this and other summaries.

III. SUMMARY OF THE FINDINGS

This section will discuss the (A) General Philosophy Consensus, (B) Scope of Content Consensus, (C) Delivery Systems Consensus, (D) Topical Coverage Consensus and (E) Current Issues.

A. General Philosophy Consensus

The philosophical questions addressed involved the nature of knowledge, classification systems, and models which encompass change. The majority of the participants seemed to be comfortable with the domains of knowledge, adaptive systems, and the mutual interaction provision advocated by the Jackson's Mill effort (Figure 1).

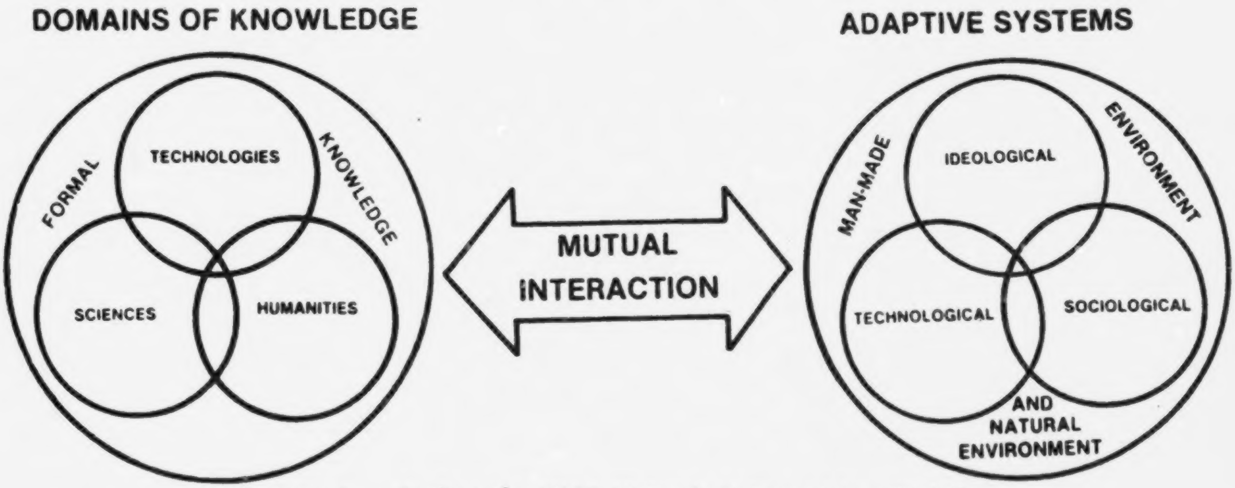


Figure 1. Jackson's Mill Mutual Interaction Model

Delivery systems which are open-ended and provide for individual differences were favored. The systems advocated by the Maryland Plan appeared to gain general acceptance due to their multi-disciplined nature and more academic approach.

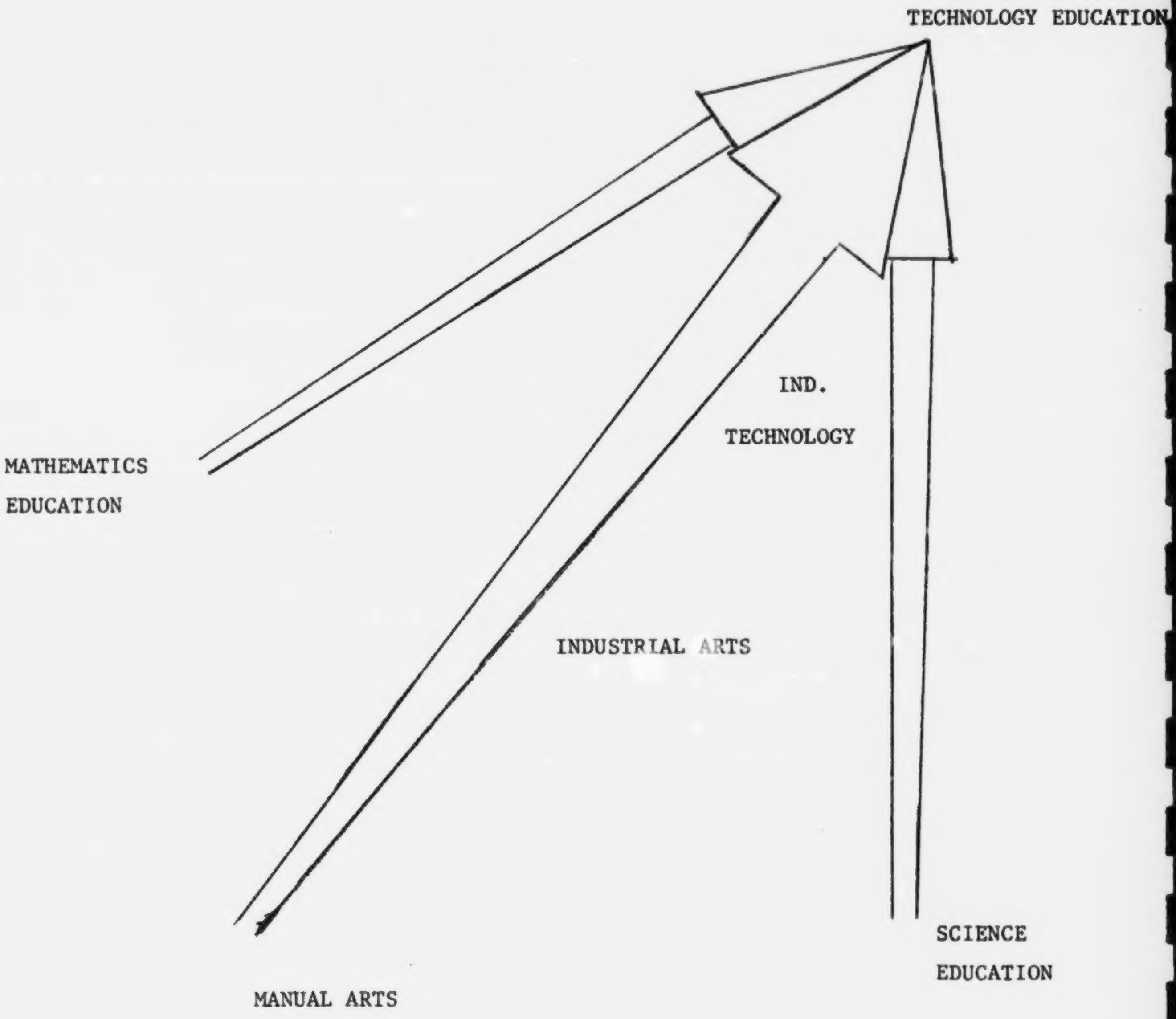
In any curriculum project of this depth, it is important to provide a basis for change as appropriate to the changing knowledge base. Participants of the conference recognized this in the discussion of the appropriate name for our discipline. Historical terms of manual training, manual arts and industrial arts have reflected changes in curriculum emphasis and scope. The current changes occuring in technology have led to numerous name suggestions that incorporate "technology" in the title. In resolving the different opinions concerning possible name changes of industrial arts, a resolution was reached which reflects current, near future and future emphases. Figure 2 reflects this resolution which is:

(a) Current curricula that consists primarily of woods, metals, drafting, and auto mechanics should retain the name of "Industrial Arts".

(b) Curricula that incorporate the content areas of technology, to be developed in this project would utilize the term "Industrial Technology". Application of this term prior to integration of technology concepts and emphases would mislead the public and potentially retard significant curriculum improvements.

(c) Curricula that fully implement the new technology emphases and which coordinate in an interdisciplinary fashion with curricula in science, mathematics, business education, economics, and others that are also incorporating technology concepts could employ the term "Technology Education". These terms suggests far more than the emphasis of technology in the current discipline. It implies the emergence of a totally new discipline that incorporates the collective

Figure 2. Trends in Industry and Technology Curriculum Development



knowledge and trends of a number of current disciplines. An "umbrella" curriculum that includes the social impacts of technology, the economics of technology, the physical and mathematical foundations of technology, the broad application of technology in living and working, and the research and development processes to create new technology will incorporate knowledge drawn from a diverse number of traditional areas. Development of a "Technology Education" curriculum therefore is an end objective that will require participation of teacher education institutions, public schools, current disciplines and the general public. While those of us in Industrial Arts today may have a vision of where many disciplines are themselves moving, it is also clear that as one of many disciplines to be merged, we cannot create this end objective in isolation from others.

B. Scope of Content Consensus

Industrial arts has encompassed topics involving industry use of metals and woods to manufacture a variety of products. There has been an emphasis on use of woods in furniture products and building construction and the use of metals and metal processing to develop both home and industry products. Some programs have also encompassed aspects of the electronics industry and automobile service industry. The methodology employed to teach these topics has emphasized development of manual skills through laboratory experience in product development and processing. Because of this emphasis on "learning by doing", industrial arts is closely identified with vocational education programs that have objectives to train people for entry level jobs emphasizing manual skills. Many industrial arts programs provide advanced courses in machining, welding, drafting, and woodworking that are virtually indistinguishable from vocational programs in cabinetmaking, tool and die, welding, auto mechanics, etc. offered at community colleges and vocational high schools. Participants recognized that current industrial arts programs serve as prevocational and career exploration agents in addition to providing general education information and skills.

Use of the structured worksheets in small group discussion resulted in reexamination of the goals and content scope of industrial arts. Appendix A includes the means of participant's responses to worksheets utilized. Worksheet #1 included some items which dealt with the scope of the content in the curriculum of industrial arts. The following conclusions may be drawn from Worksheet #1:

a. The content of industrial arts should reflect awareness of the course content in science, math, and other curriculum areas (item 18).

b. The primary focus should be to provide a broad exposure to technology (item 5).

c. Content should include a study of management techniques involving human and other resources (item 17).

d. The primary focus should be industry and industry practices involving materials, processes, and products (item 1).

e. The content should be expanded to include more processes, materials and products (item 15).

f. The primary focus should provide a broad exposure to all science and technology related fields (item 2).

Worksheet #2 also contained items which have implications for the content of industrial arts. In summary:

a. Students should learn the operational principles and construction methods for alternate energy systems (item 13).

b. Students should learn the principles of alternating and direct current electricity, communications electronics, digital electronics, industrial electronics and home electrical service wiring (item 12).

c. Experiences should be provided in applying mathematics, science, economics and English skills and knowledge in industry related activities (item 3).

d. Students should become familiar with materials used in construction and manufacturing such as metals, woods, plastics, ceramics and glass.

e. Students should imagine and produce new products through research and development experiences (item 18).

f. Students should experience work activities related to a large variety of industrial careers.

g. Students should acquire an understanding of the relationships among government, industry, education and other institutions concerning labor problems, ecology, balance of trade, regulations, investments and profits (item 15).

h. Students should develop the ability to select products of higher quality and endurance (item 17).

i. The role of support services such as data processing, maintainance, safety and management should be learned (item 7).

j. Transportation systems including automobiles, conveyors, augers, boats, aircraft and non-fuel vehicles should be employed (item 15).

In summary, the participants recognized the need for broader topical inclusion in industrial arts, the need to emphasize technology and to integrate through application, concepts taught in other disciplines.

C. Delivery Systems Consenus

John Dewey's influence in curriculum is well evidenced by the emphasis in industrial arts on learning concepts through the completion of activities involving disigning, fabricating, or servicing of products. Laboratory activities may be quite varied however in the degree of individualization of activities, the selection of activities, the time spent on an activity and the complexity of the activity. Discussion and worksheet responses of the participants lead to the following conclusions concerning delivery systems for industrial arts curriculum:

a. Active involvement of students in activities that result in achievement of learning goals should be maintained in industrial arts.

b. Activities which require cooperation among students in planning and executing those plans is to be encouraged.

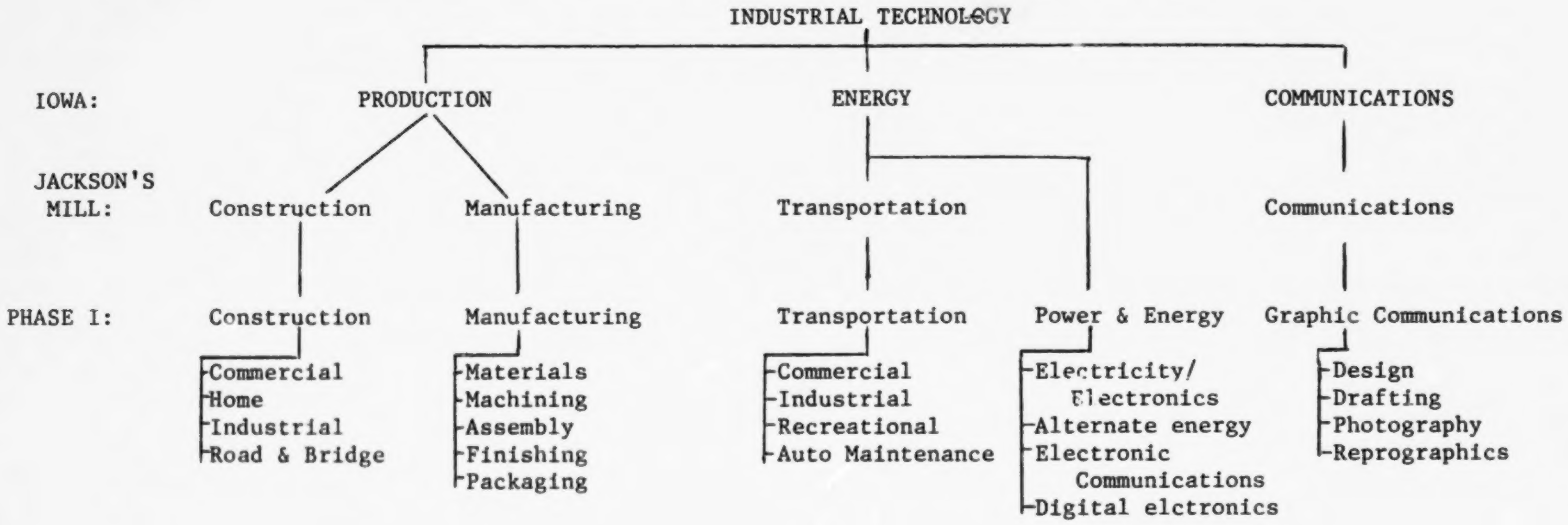
c. Activities which encourage creativity and innovation are encouraged and preferred to activities requiring identical performances of all students regardless of present skill and knowledge levels.

d. Curricula of industrial arts should be sequenced to minimize redundancy and provide specialization and concentration at higher levels of coursework.

D. Topical Coverage Consensus

The Iowa Guide for Curriculum Improvement in Industrial Arts, K-12, A Study of Industrial Technology, identifies three major clusters of content for high school: Materials & Processes, Communications, Production and Energy. In the Jackson's Mill plan four clusters are proposed consisting of manufacturing, construction, communications and transportation. Phase I proposed that a fifth cluster, Power and Energy be added to the Jackson's Mill plan to recognize that area of Iowa's Guide not included in the Jackson's Mill. While the number of clusters may vary from one orientation to another, nearly all share the same common elements and topical coverage. Moreover, it is clear that the clusters share a common base of elements that serve to integrate all of the clusters. These common elements draw upon the physical sciences, business sciences, social sciences and management sciences for concepts related to the transformation of resources (materials, information, personnel) to useful products (machines, appliances, structure, services, knowledge) and the maintenance of these products using processes utilized in modern industry and technology. Figure 3 depicts the above clusters and representative elements common to all clusters. The number of cluster titles adopted and the degree of specialization of course offerings will reflect the size of a school program (number of students, teachers, sessions per day, etc.) and the degree of community and school support.

FIGURE 3. CLUSTERS AND TOPICS



COMMON ELEMENTS: Systems, Materials, Research and Development, Computer Applications, Safety, Quality Control Testing, Marketing, Distribution, Personnel Organization, Profit/Loss/Investment, Planning, Inventory Control, Acquisitions, Management, Careers, Environmental Impact, Entropy, Parsimony, Maintenance, Advertising, Consumer Protection, History, etc.

The identification of topics to be included, the sequencing of those topics and the organization of those topics into courses is a continuous curriculum activity. At the high school level, the selection and organization of topics must reflect the prior experiences of students in the curriculum of the middle school and even the elementary school. Because districts vary widely in their requirements concerning middle (junior high) industrial arts, many high schools must offer coursework which provides basic concepts and experiences which students may not have acquired at the middle school level. The curriculum planning committee has identified the following understandings and skills (from worksheet #4) that a student should possess under ideal circumstances prior to entry into high school (9th grade).

a. Correct and safe operation of:

1. hand saw, 2. hand plane, 3. hand drill, 4. hammer, 5 electric drill, 6. power saw, 7. soldering iron, 8. gas welder, 9. tin snips, 10. metal grinder, 11. wire strippers 12. crescent wrench, 13. hydraulic jack, 14. box end wrench, 15. metal files, 16. microcomputer, 17. camera, 18. silkscreen.

b. Ability to:

1. Fasten sheet metal with solder or rivets.
2. Construct three types of wood joints.
3. Produce isometric projection drawings of an object.
4. Finish a metal surface.
5. Produce a computer program.
6. Sharpen drills and hand plane blades.
7. Replace spark plugs in an engine.
8. Change a tire on an automobile.
9. Draw a floor plan of a house.

c. Describe, recall, recognize or solve problems related to:

1. Labor organization, classification, compensation.
2. Safety laws and liability.
3. Research and development.
4. Cost estimation.
5. Production planning.
6. Materials acquisition and inventory.
7. Market research, advertising, selling.
8. Materials processing (glass, metal, ceramic, wood, plastics).
9. Product durability.
10. Energy conservation.
11. Energy production.
12. Graphic communication.
13. Electronic communication.
14. Automation and robots.
15. Employment opportunities, requirements, trends.
16. Electrical wiring, switches, transmission.
17. Industrial hazards.
18. Supervision, management, hiring, allocation.
19. Engine power, efficiency, operation, emission.

Based on the previous lists, it may be concluded that, prior to 9th grade, students should have prior exposure to manufacturing, power and energy and communications concepts including many common elements involving an understanding of industrial organization, goals and personnel. Many middle schools have adopted the enterprise system or a curricular model to achieve the above knowledge acquisition. This delivery system, which simulates a corporate structure to manufacture and market useful products, has the advantage of integrating the elements of each cluster. Where specialized unit laboratories exist, it does require coordination of laboratory usage to insure students are exposed to the various activities of the curriculum.

An alternative entry level curriculum combines a sequence of classroom and laboratory experiences in the clusters with a conscientious effort to relate each experience to prior or subsequent experiences.

Figure 4 depicts an adaptation of the plan developed by several school districts to provide a sequence of courses with increasing levels of specialization. Each district would develop such a plan based on total resources available. The Curriculum Planning Committee did reach consensus that the high school curriculum should exhibit a sequence of instructional units that minimize redundancy and builds upon prior and current learning activities.

A sequenced curriculum would start from a broad general course which provides a survey of industrial organization, processes, materials and services. Subsequent coursework would provide for the acquisition of basic skills in elective areas appropriate to the student interests and academic talents. Advanced coursework should integrate prior coursework and permit creative, problem solving activities. Final experiences should provide for preprofessional or vocational experiences appropriate to the students post-high school planning.

To achieve this broader curricular objective requires the development of new units of instruction to supplement existing curricular materials. These units or modules could be integrated into existing courses or be assembled to form new courses which would be the first step in the evolution of industrial arts to industrial technology and ultimately to technology education.

E. Current Issues

A number of issues remain to be resolved. These will be summarized under subheadings of (1) definitions, (2) workshop focus, (3) guidelines development (4) methods for change and (5) alternative curricula.

Definitions

Problem: A definition of Industrial Technology should be adopted which successfully communicates the nature of the curriculum to the

FIGURE 4. A MODEL OF A SEQUENCED HIGH SCHOOL CURRICULUM

Level:	Entry (9th)	Acquisition (10th)	Integration (11th)	Specialization (12th)
Scope:	Organization of Industry Material processing (woods, metals, plastics) Product design, specification, drafting Support Services computing, safety, maintenance, management marketing	Machining metals, plastics, glass Woodworking Ceramics, leather - - - - - - - - - - - - - - - - - - Concrete, cement, bricks, framing excavating, finishing, furnishing - - - - - - - - - - - - - - - - - - Mechanical Drafting Architectural Drafting Electronic Drafting Photography Reprographics - - - - - - - - - - - - - - - - - - Electricity/electronics Computer programming Alternate energy - - - - - - - - - - - - - - - - - - Automotive systems Small engines Aircraft Watercraft	Research and Development: Ideation Specification Design Prototype construction Testing and evaluation Costing Market surveying Production planning - - - - - - - - - - - - - - Advanced Topics: Manufacturing Home Construction Graphic Communications Digital Electronics Automobile Maintenance	High Technology: Robotics Automation Computer Aided Design Energy Systems Design Transportaion Systems Computer Sciences Laser Technology Holography - - - - - - - - - - - - - - Vocational Programs: Cabinet Making Tool and Die Automotive Repair Data Processing Welding Construction Trades TV Repair Air Conditioning & Heating Systems
Methods:	Enterprise system	Unit laboratories	General Laboratory, Classroom & field experience	Independent (self-directed) Cooperative Placement Advanced (college) placement Vocational placement
Coordinated Learning Activities	Math (geometry applications) Science (electricity) English (advertising manuals) Business (typing shorthand)	Math (algebra-network analysis) Science (chemistry, biology) English (journalism) Business (accounting) Home Econ. (foods & textiles industry)	Math (trigonometry, solid geometry) Science (physics) English (speech, creative writing) Business (word processing) Home Econ. (consumerism)	Math (calculus) Science (applied) Business (sales) Home Econ. (Economics)
Supportive Courses:	Foreign Language (Spanish, German, French) Art (drawing, painting)	Foreign Language American History Art (art metals, ceramics)	Foreign Language Government Art (commercial)	World History Economics

general public.

Solution: In view of the support and impact that the Jackson's Mill plan has had, it is suggested we adapt the definition of industry and technology used in that plan (Page 2 of the 1981 report). The definition would read approximately as follows: "Industrial Technology is the study of those societal economic institutions that create and utilize tools, techniques, resources, and systems to produce goods and services that meet the needs and wants of individuals and society and extends the human potential."

Workshop Focus

Problem: Funds exist to sponsor four workshops of ten individuals each for the purpose of developing new curriculum materials to facilitate the improvements of the high school level curriculum.

Solution: It is suggested that one workshop be dedicated to each of the following topics:

a. Microcomputer applications in Industrial Technology. The goal of this workshop would be to construct curriculum material that facilitates the learning of:

   - the nature and construction of a computer
   - the characteristic operation of a stored sequence of instructions
   - the analysis of industrial process and control operations to which a computer may be applied
   - the application in industry for product design
   - the application in industry for cost estimation
   - the application in industry for production and construction planning

- the application in industry for machine control
- the application in industry for inventory control
- the application in industry for environmental control
- the application in industry for financial control
- the application in industry for personnel management
- the application in industry for research and development
- a historical perspective
- the effect of computers on quality of life
- probable future developments

b. High technology applications in graphic communications.

The goal of this workshop would be to construct curriculum materials that facilitate the learning of:

- computer typesetting and word processing
- computer aided design
- one step color photography
- xerography technology
- holography technology
- laser printing
- offset processes
- rotogravure processes
- modern substrates
- computer-aided photography
- light sensitive materials
- a historical perspective of graphic communications
- graphic communications developments and their effect on the quality of life
- sensitometry for image reproduction

c. Technology in manufacturing

The goal of this workshop would be to construct curriculum materials that facilitate the learning of:

- numeric control and computerized numeric control
- product testing (x-ray, sound conduction, etc.)
- effects of manufacturing developments on the quality of life

- planning methods (PERT/CPM, GHANTT CHARTS)
- fiberglass construction and processing
- management practices in manufacturing
- laser cutting and welding operations
- vacuum metal deposition processes
- manufacturing in space
- a historical perspective
- the use of ceramics
- the use of plastics
- coatings and finishes
- assembly line automation
- robotics

d. Power and energy technology

The goal of this workshop would be to provide supplementary curriculum materials in the following topics:

- generation, storage, transportation and use of hydrogen fuels
- photovoltaics
- analog/digital - digital/analog interface
- integrated circuit manufacture and design
- hydroelectric energy generation
- bio-mass energy generation
- stepping motors & controls
- wind generators
- historical perspective
- computer design of electronic circuits
- effects of developments in power & energy on the quality of life
- probable future developments
- solar energy
- nuclear energy
- automotive computer systems
- hydraulics & pneumatics
- fiberoptics in electronic communications

Guidelines Development

Problem: Curriculum Planning Committee members indicated a need for state guidelines materials that specify in greater detail those topics ideally included in an industrial technology program.

Solution: It is suggested that the Curriculum Advisory Panel members and project personnel develop a draft of a supplement to the Iowa Guide for Curriculum Improvement in Industrial Arts which provides:

a. Suggested topics of inclusion at the high school level,

b. Alternative suggested course outlines for a minimum, average and exemplary program in industrial technology,

c. Recommendations for facilities and equipment for industrial technology, and

d. A bibliography of suggested texts, audio visuals, and activities for topics in (a) above.

Methods for Change

Problem: Many programs resist change due to (1) expectations of parents, teachers and students, (2) lack of materials and equipment to teach new technology and (3) lack of training of current staff in new technology areas. Methods are needed that will reduce the impediments for change.

Solutions: It is suggested that program changes can be accelerated by use of the following methods: (a) Utilization of local AEA personnel to coordinate more frequent curriculum planning and faculty in-service training sessions in the new curriculum areas. (b) Identification of current equipment and materials costs and facilities required of all new curriculum materials developed through Cadre support activities. (c) Development by Cadre and teacher workshop participants of newspaper, radio and TV service announcements appropriate to inform the public of new programs and industrial technology content. (d) Presentations to professional counseling, principals, superintendents and school board associations of the needs and programs available in industrial technology. (e) The solicitation of support from private industries for equipment and materials as well as guest speakers and field trip visits to support new curriculum activities in industrial technology.

Alternative Curricula

Problem: Many new topics suggested for the improvement of the curriculum in industrial arts are also being considered or implemented by science, art, mathematics and business education teachers.

Solution: Industrial Technology curriculum should reinforce the learning achieved through other disciplines with particular reference to application in industry. Where topics included in the industrial technology (such as computer programming, laser technology, digital (binary) arithmetic, computer graphics, etc.) are successfully taught in other programs, there is no justification for duplication. It is suggested that an interdisciplinary technology education program may be emerging in such situations and that this trend be reinforced through interdisciplinary curriculum planning and coordination committees at the local district area.

APPENDIX A

Means Responses for Worksheets One and Two

MEANS - ALL GROUPS

WORKSHEET #1

This worksheet is designed to help focus on the philosophical issues confronting designers of industrial arts programs and curriculum materials.

DIRECTIONS Statements that reflect certain beliefs and desires about industrial arts are listed below. Please indicate your level of agreement or disagreement with each statement by recording one of the following numbers in the blank provided.

1. Strongly Agree
2. Agree
3. Neither Agree or Disagree
4. Disagree
5. Strongly Disagree

1.85 1. The Primary focus of industrial arts courses should be industry and industrial practices involving materials, processes, & products.

2.50 2. The Primary focus of industrial arts courses should be to provide a broad exposure to all science and technology related fields.

3.62 3. The Primary focus of industrial arts should be to prepare the student for vocational training and/or job entry.

2.3 4. The Primary focus of industrial arts should be to explore careers in industry and technology.

1.5 5. The Primary focus of industrial arts should be to provide a broad exposure to technology.

3.26 6. The Primary focus of industrial arts should be to provide general life skills.

1.4 7. A broad introductory industrial arts course should be required for all high school students.

2.85 8. Technology is a separate curriculum area that can best be taught in industrial arts classes.

1.90 9. Industry is a societal institution that should be studied by all students.

1.8 10. A study of industry can best be conducted through industrial arts classes.

3.0 11. Complex projects in woods, metals, electronics, etc. should be encouraged.

4.1 12. The use of the student large project is the best method of relating concepts and skills in industrial arts classes.

3.4 13. A need exists to develop more innovative ways to incorporate large project construction into the industrial arts high school curriculum.

1.4 14. Group projects are a valuable teaching tool that has been underutilized.

2.1 15. Industrial arts course content should be expanded to include more processes, materials, and products.

3.9 16. The use of projects that have been designed and constructed by individual students is the best method of relating concepts and skills.

1.7 17. Content for industrial arts classes should include a study of management techniques involving human and other resources.

1.0 18. Industrial arts course content should reflect an awareness of the course content in science, math, and other curriculum areas.

MEANS - ALL GROUPS

HIGH SCHOOL INDUSTRIAL ARTS/TECHNOLOGY CURRICULUM PLANNING COMMITTEE

Worksheet #2

GOALS FOR HIGH SCHOOL INDUSTRIAL ARTS

I. Directions Listed below are possible goals for High School Industrial Arts and Technology Curricula. Indicate your agreement with each goal by recording, in the blank provided, one of the numbers:

1 = strongly disagree that this is an appropriate goal
2 = slightly disagree with this as a goal
3 = neither agree no disagree with this goal
4 = somewhat agree that this is an appropriate goal
5 = strongly agree that this is an appropriate goal

4.02 1. Industrial arts should provide broad exploration of the organization and specialization of work in a broad variety of industries.

4.20 2. Students should be provided the opportunity to experience work activities related to a large variety of industrial careers.

4.9 3. Industrial arts should provide specific experiences in applying mathematics, science, economics and English skills and knowledge in industry-related activities.

4.41 4. Students should become familiar with materials used in construction and manufacturing such as metals, woods, plastics, ceramics and glass.

4.1 5. Students should acquire knowledge and skill in the processing of materials including cutting, drawing, shaping, fastening, and finishing.

4.1 6. Industrial arts should acquaint students with the interaction of product design, manufacturing, marketing, inventory and distribution.

4.11 7. The role of support services in industry such as data processing, maintenance, safety and management should be understood by students after completing courses in industrial arts.

3.80 8. Skill in conceptualizing, specifying operational characteristics, estimating costs, designing, and developing detailed drawings of products to manufacture should be attained by students in industrial arts.

3.20 9. Students will understand mechanical, electrical, chemical and psychological hazzards of the industrial work setting and understand accident and stress reduction methods and costs.

2.61 10. Students will be provided the opportunity to develop skills for immediate employment at an entry level.

4.05 11. Students will have the opportunity to develop skills and knowledge of the graphics industry including printing techniques, photographic processes, silk screen techniques, computer aided design and typesetting, press operations, etc.

5. 12. Opportunity will be provided to learn the principles of alternating and direct current electricity, communications electronics, digital electronics, industrial electronics and home electrical service wiring.

4.90 13. Students should have the opportunity to learn the operational principles and construction methods for alternate energy systems such as solar collectors, wind generators and photovoltaic systems.

3.91 14. The industrial arts program should provide girls and boys the skills and knowledge utilized in designing, planning, and construction of homes, small business buildings, and concrete structures.

4.10 15. Transportation systems including operational and maintenance characteristics of automobiles, industrial conveyors, augers, boats, aircraft and non-fuel vehicles should be explored in coursework of the industrial arts curriculum.

4.2 16. Students should acquire an understanding of the relationships among government, industry, education and other social institutions concerning labor problems, ecology, balance of trade, regulations, investments and profits.

4.2 17. The Industrial arts program should develop the ability in the student to select and purchase products of higher quality and endurance for a given price.

4.31 18. The Industrial arts curriculum will provide students an opportunity to not only imagine, but actually produce (invent) new products through research and development experiences.

II. Please add additional goals that you feel are very important for High School Industrial Arts.

19.

20.

21.

APPENDIX D

SUMMARY OF APRIL 6, 1984 CURRICULUM ADVISORY PANEL MEETING

High School Industrial Technology Curriculum Project

Summary of April 6, 1984 CAP Meeting

I. Philosophical BASES:

"Technology is the science or study of the practical or industrial arts, applied sciences, etc., and the system by which a society provides its members with those things needed or desired." (Guralnik, 1982). "The study of technology should result in a person who (1) adjusts to the changing environment, (2) deals with forces that influence the future, and (3) eagerly participates in controlling his or her own destiny." (Sterry and Wright, 1984). Industrial Technology Education at the high school level is based on the following premises:

1. Industry may be defined as a societal institution that develops and uses technology in conjunction with human and natural resources to develop, produce (substantially change the form of materials), and service industrial material goods. While industry consists of many subsystems, the major (dominant) systems of industry are communications, manufacturing, construction, transportation and energy.
2. Industrial Technology education is that field which provides opportunities for all students from elementary through higher education to develop an understanding about the technical, consumer, occupational, recreational, organizational, managerial, social, historical and cultural aspects of industry and technology. Furethermore, it is a field wherein students acquire industrial-technical knowledge and competencies through creative and

problem-solving learning experiences involving such activities as experimenting, planning, designing, constructing, evaluating and using tools, machines, materials and processes.

3. The purpose of Industrial Technology education is to provide a wide range of experiences that further the awareness and development of each student's career potential, technical abilities, judgment, self-reliance, and resourcefulness and knowledge to succeed as an effective producer and/or consumer in our technological society.
4. Students completing programs in Industrial Technology will understand and appreciate the evolution and relationships of society, science, industry and technology.
5. Students in Industrial Technology will establish beliefs and values based on the impact of industry and technology and how they alter environments.
6. Students will develop abilities in the proper use of tools, techniques and resources of technical and industrial systems.
7. Students will develop creative solutions to present and future societal problems using technical means.
8. Students will explore and develop human potentials related to responsible work, leisure and citizenship roles in a technological society.
9. All high school students need a basic foundation of knowledge and experience about industry, technology and their societal context.
10. Student experiences should include research and development, industrial/technical systems, and technical services.
11. Industrial technology programs should provide specific experiences in communications, manufacturing, construction, transportation and

energy.

12. Curriculum should include both the productive and management activities of industry and technology.

13. Experiences should be provided concerning the design of products and systems, and the productive activity of systems.

14. Separate program structures are required for schools differing in size and resources.

15. Both research and development, and enterprise experience should be included in the curriculum.

16. Course activities should be designed to reinforce concept understanding and mastery in addition to providing manipulative skills.

17. Industrial technology curricula should be relevant and appropriate to males and females pursuing all possible careers whether they be vocational or professional in nature.

II. Curriculum Structure

The Jackson's Mill curriculum project has served as a guide for the conceptualization of the high school curriculum. The four concept areas identified by this plan are communications, construction, manufacturing and transportation. Because Iowa schools have also developed coureses in electronics and alternate energy, a fifth concept area, "Power and Energy" has been added to the Jackson's Mill. Auto mechanics, which is traditionally a part of Power and Energy in Iowa schools would now be placed in the "Transportation" cluster. Power and Energy would therefore consist predominantly of electricity, electronics, fuels, alternative energy, fluid systems (hydraulics and pneumatics) and computer technology. It is recognized that topics of the Power and Energy cluster may support all of the remaining four clusters and that some school systems may organize their curricula using only four clusters.

It was recommended that in most schools systems, individual course titles should be descriptive of the topical inclusion and would not bear the cluster (concept area) title, thus avoiding confusion with courses offered at the middle school level that often do use the cluster titles at the broad, exploratory level.

It was recommended that within each cluster, courses be developed that are sequential in nature, with each subsequent course providing greater specificity to a more narrowly defined area. Research and development experiences are suggested as a major focus of the advanced level courses although size of school and staffing will determine the extent and nature of this experience.

Utilization of the enterprise system at some level within the curriculum is strongly advocated by the Jackson's Mill model. This experience, if provided at the high school level, should provide substantially greater depth of experience and content than those currently obtained at the middle school level.

III. Tasks Defined that are to be Completed Prior to May 12, 1984.

Members of the CAP committee were asked to begin developing appropriate objectives, topics and courses for three of the five concept areas to be included in the summer workshops. The areas to be developed are:

1. Communications
2. Manufacturing
3. Power and Energy

Results of the CAP members activities will be used to serve as a basis for guiding the curriculum development activites of workshop participant. To provide some commonality among CAP member's reports for the April 12 meeting, the following suggestions are offered:

1. Develop three sets of curriculum, one for schools enrolling fewer than 400 students and having only 1 or 2 industrial technology teachers, one for schools with enrollments of 400 to 800 students and two or three teachers, and one for schools enrolling more than 800 students and having more than three teachers.
2. Specify, in outline form, the objectives to be met by each course, the activities suggested to meet those objectives, the topics (content) to be covered, the prerequisite experiences and the suggested subsequent courses or activities. Figure III.1 may serve as an example.
3. Produce overhead transparencies of your work and, if budget provides, 15 copies for dissemination at the CAP meeting of May 12.

Figure III.1 Concept Area: Power and Energy

Grade	Objectives	Topics	Activities	Prior Experience	Post Experience
9	Title: Energy Systems Length: One semester Freq: 1 hour per day, 5/wk	General: Solar, wind, thermal, electrical, mechanical, water, chemical	General: Resource Research, experimentation, system design, system construction	Hand tools: snips, saws, pliers, screw drivers, volt meters, hammers Courses: Algebra, Ind. Arts, Science	Electricity, fluid systems, auto systems
	Students will:	Topics covered are:	Students will:		
	1. Be able to describe the major sources of energy and their rates of depletion 2. Be able to provide examples and explanations of energy conversion systems 3. Be able to describe and calculate system efficiency indexes 4. Be able to measure energy usage and compare machines on cost-effectiveness 5. Be able to construct a solar collector system for thermal and electrical energy production	1. Types of energy 2. Units of measurement for energy 3. Measurement instrument 4. Principles of energy conversion 5. Comparative costs of energy production 6. Principles of energy conservation 7. Efficiency measures of energy production and usage systems 8. Principles of construction of energy production systems	1. Write a summary report on energy supply and usage trends 2. Utilize a pyronmeter, thermo couple, DVM, and flow meter 3. Use a computer program to perform a home energy audit 4. Construct a photovoltaic, battery and light system 5. Construct a solar collector of their own design 6. Evaluate insulation properties of 5 materials		

APPENDIX E

EVALUATION PROCEDURES

Evaluation of the High School Industrial Arts Project
Years 1-3

Introduction

By the completion of year 2 of the project, three major instructional units should be developed, tested and available for dissemination to high schools in Iowa. In addition, an item bank of test items will be available for retrieval requests by Iowa teachers. A philosophical basis for curricula in industrial arts will be in place and revision of guidelines for Industrial Technology initiated.

The evaluation of the products and activities of this project will occur at several levels. This document provides an overview of the evaluation system to be utilized.

Levels of Evaluation

Figure 1 depicts seven major levels on which to base the evaluation of the High School Industrial Arts Curriculum Project. Level I corresponds to the development of the philosophical basis for the high school curriculum in Iowa concerning industrial arts and technology. Sources of information are obtainable from the Curriculum Advisory Panel, Curriculum Planning Committee, the Iowa Industrial Arts Cadre, industrial arts teachers and workshop participants that contributed to development, testing, or use of the resulting curriculum.

Level II involves evaluation of the topical selection and exclusion reflected in the developed curriculum content guidelines and developed instructional materials. Ratings obtained from all sources may be utilized to assess the adequacy of the topic inclusion, topical emphases, coordination with existing disciplines, nonsexist orientation, feasibility for delivery and responsiveness to the philosophic bases.

Level III involves evaluation of the materials developed to facilitate adoption of the developed curriculum. All sources may be sampled to obtain ratings of developed reading materials, testing materials, audio visual materials, student activities and teacher guidelines.

Level IV concerns evaluation of the instructional methods developed or suggested for delivery of the curriculum content. All sources identified may be sampled to rate the effectiveness of demonstrations, individual student activities, group projects, field trips, self instruction programs and other techniques utilized.

Level V involves an evaluation of the effectiveness of the curriculum in meeting the goals and objectives stated for the curriculum. Teachers, students and expert evaluation personnel will be sources for this evaluation level. Effectiveness will be assessed on the basis of

(a) Demonstrated gain in student knowledge and appreciation beyond that expected due to maturation, other curricula, or effects independent of the experimental curriculum.

(b) Teacher satisfaction with the new curriculum and preferance over prior curricula utilized.

(c) Adequate evaluation outcomes in the four prior levels described above.

Figure 1. Evaluation Taxonomy

	Evaluation Information Sources					
LEVEL	Teachers	School Personnel	Students	Advisory Committees	External Evaluator	Workshop Participants
I. Philosophic Base	✓			✓		✓
II. Curriculum Content	✓	✓	✓	✓	✓	✓
III. Curriculum Materials	✓	✓	✓	✓	✓	✓
IV. Instructional Materials	✓	✓	✓	✓	✓	✓
V. Curriculm Effectiveness	✓		✓		✓	
VI. Project Processes	✓			✓	✓	✓
VII. Project Documentation				✓	✓	

Level VI evaluation involves an examination of the project processes leading to the development, testing, and implementation of new curriculum directions, materials, dissemination and adoption. In particular, this level focuses on the cost effectiveness of the project to meet the objective of improving Industrial Arts in the state of Iowa. Ratings from teachers, various committees utilized, workshop participants and the independent assessment of the external evaluation will be used as sources for this level.

Level VII provides the summative evaluation of the entire project as documented in a final report for the project. The Curriculum Advisory Committee and Cadre will be the major reactors to documentation provided by the project personnel and the external evaluator.

Research Designs

The evaluation levels described above rely heavily on information supporting or rejecting statements concerning the acceptability and effectiveness of the products and process of this project. The information utilized to support or refute such statements must evoke a level of confidence in use of that information. Such confidence is typically obtained when statistical procedures are employed to test hypotheses concerning relationships among reliable variables. These variables are typically scores obtained from reliable measurement instruments and classifications of observed units.

Measures of student knowledge and attitude and user satisfaction with the project products form the basis of information for statistical analyses supporting the evaluation of this project. The research designs employed specify the methods of statistical analysis.

Figure 2 summarizes the research designs, hypotheses, analytic procedures and variables to be employed. With the exception of student achievement, the designs utilized are simple tests for ratings being positive beyond that expected by chance assignment of rating values. The design to be utilized in assessing effect of new materials on students involves comparing three groups of students: Those receiving the new curriculum in an Industrial Arts course, those not receiving the new materials in a similar industrial arts course, and students not enrolled in Industrial Arts. An analysis of covariance design will be utilized at both the student level of observation and class level. Where new materials are used independently by students and interaction among students can be assumed to have negligible effects, the student will be the unit observation. All other analyses will treat the class as the unit of observation and group means on the obtained measures used as variable scores.

Measurement Instruments

Rating forms will be constructed using 5 point Likert scales where 3 indicates neutral, 1 indicates highly unsatisfactory and 5 indicates highly satisfactory. These rating forms will be constructed with items balanced for negative and positive statements. (Negative items will be reversed in scoring.) The forms developed will generate both subscores for specific subtopics and a total score for overall responses. Average item score values will be utilized to retain the 5 point scale interpretation

Student achievement and attitude ratings consist of individual module and unit measures and combined (comprehensive) measures. The combined measures will be utilized prior to and subsequent to use of instructional modules in a school and administered at similar time periods across schools. Unit measures will be administered immediately following completion of a unit. The instruments to be employed will be developed by workshop participants as part of the curriculum development activity. All instruments will be pilot tested.

Figure 2. Research Designs, Statistical Analyses and Variables Employed in the Evaluation

Level	Design/Hypothesis	Analyses	Variables
I.	Mean Rating on Likert Scale $H_o: \mu = 3$ $H_A: \mu > 3$	Student t-test $\alpha = .05$, 1 tailed	Curriculum Philosophy Rating Form Score. (5 point scale)
II.	Mean Ratings from groups on a Likert Scale $H_o: \mu_1 = \mu_2 = \dots \mu_6$ and $\mu_{Total} = 3$	One way ANOVA $\alpha = .05$ t-test, $\alpha = .05$	Curriculum Content Rating Form Score. (5 point scale.) Groups defined by source
III.	Mean Ratings from Groups and Combined Groups Mean $H_o: \mu_1 = \mu_2 = \mu_3$	One way ANOVA $\alpha = .05$ t-test $\alpha = .05$	Instructional Materials Rating Form: total score. Groups defined by source.
IV.	Mean Ratings on a Likert Scale. Analysis by groups and total. $H_o: \mu_1 = \mu_2 = \mu_3$ $H_o: \mu_{Total} = 3$	One way ANOVA $\alpha = .05$ t - test $\alpha = .05$	Curriculum Methods Rating Form: Total Score
V.	Student Achievement and Attitude measures for groups defined by: I.A. course - new curriculum I.A. course - old curriculum, No I.A. course. $H_o: \mu_1 = \mu_2 = \mu_3$ $H_A: \mu \neq (\mu_2 + \mu_3)/2$	Analysis of Covariance with Apriori contrasts $\alpha = .05$	Dependent: Post-test measures Independent: Treatment Group Covariates: Pre-test measures GPA ITBS Composite (9th grade) Sex classification SES estimate Class size Teacher's years experience
	Teacher Mean Ratings on a Likert Scale $H_o: \mu = 3$	t-test, $\alpha = .05$	Curriculum Effectiveness Rating form score

Figure 2 continued

Level	Design/Hypothesis	Analyses	Variables
VI.	Mean Rating on a Likert Scale $H_o: \mu = 3$	t-test, $\alpha = .05$	Project Activities Rating Form Score
VII	Consensus, Documentation	None	Cadre Review Meeting and Evaluator Presentation

Data Encoding and Analysis

Comprehensive tests and rating form responses, as well as teacher and student biographic data forms, will be transmitted to project personnel upon completion of the administration. Scoring and encoding of the data will be completed at I.S.U. for subsequent analysis using SPSSX programs on the NAS AS/6 computing facility.

APPENDIX F

GRAPHIC COMMUNICATIONS MODULE

GRAPHIC COMMUNICATIONS MODULE

IOWA HIGH SCHOOL INDUSTRIAL ARTS CURRICULUM PROJECT

GRAPHIC COMMUNICATIONS DESIGN MODULE

TEACHER GUIDE

This module has been prepared to be used in high school industrial arts/technology classes. The content covered can be infused into a wide range of courses, but it is most closely related to courses in graphic communications.

This and other modules have been prepared as a part of Phase II of the Iowa High School Industrial Arts Project. The project was conceived by the Iowa Industrial Arts Cadre and sponsored by the Iowa Department of Public Instruction.

Those persons involved in the preparation of this module include:

Jeff Bock	Des Moines	East High School	515-243-3835-Home
Dan Ford	Ottumwa	Ottumwa High School	515-684-5156-Home
Pat Janssen	Van Horne	Benton Community School	319-228-8506-Home
Ned Rasmussen	Des Moines	May Goodrell Transitional	515-274-8506-Home
John Dugger	Ames	Iowa State University	515-233-5517-Home 515-294-8341-Office

If problems arise please feel free to contact any of the individuals listed above.

Rationale

Public education is experiencing enrollment declines and adverse publicity. This along with the emphasis on required courses at the secondary level has made it increasingly difficult to justify the existance of industrial arts at the secondary level.

Criticisms of secondary industrial arts programs include: they do not support concepts covered in the "academic" classes, the content covered is out-dated, students are not expected to display a high level of achievement, and program costs far outweigh program benefits. These and other concerns need to be addressed before administrators, guidance counselors, and teachers can expect to increase their support for high school industrial arts programs.

The purpose of this project is to effect positive change in high school industrial arts programs in Iowa. It represents an attempt to address the perceived needs and problem areas that exist in the majority of Iowa high school industrial arts programs.

High school industrial arts content can be divided into five distinct areas. They include graphic communication, energy and power, manufacturing, construction, and transportation. Graphic communication content is derived from those industrial practices involving the processes, tools, and materials used in the generation and subsequent reproduction of images onto a substrate.

The skills and knowledge gained by students enrolled in graphic communication classes should be applicable in any industrial setting.

Objectives

The objectives of the module include:

1. The infusion of current industrial design practices, procedures, and tools into the graphic communication curriculum.
2. The presentation of a historical overview of design.
3. An introduction of elements and principles of design.
4. The presentation of related scientific principles as taught in secondary science courses.

Sources of Information

The sources of information are divided into four divisions. They include: textbooks that were deemed appropriate for this module; reference books that provide additional insights into the content; periodicals that new tools, processes and procedures; and other media.

LESSON PLAN- DAY 1

Title: Pre-Test and Introduction

OBJECTIVES

The student will be able at the end of this class to:

1. Define communications
2. Define graphic communications
3. Identify the major activities for the next three week period.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

Overhead & Screen

HANDOUTS AND WORKSHEETS

1. Syllabus - Listing deadlines, assignments and activities.
2. Notebook checklist
3. Copies of the pretest and answer sheets

INTRODUCTION

The first part of this class will be spent taking a pre-test. The purpose of this activity is to determine whether you have any prior knowledge about the subject matter that will be covered in this unit.

(Read the test instructions)
(Administer the test - provide 25 minutes)

Communication involves the transmitting and receiving of ideas, thoughts, messages. (Transparency 1) The channels for communication include: Sight, sound, touch, smell, taste. (Transparency 2) Think of an example of communication using each of the senses.

Most communication occurs using sight and sound. These are called visual and audio communication respectively. Visual communications can be subdivided into graphic and non-permanent communications.

Graphic communications involve the creation and use of permanent images. Permanent images are defined as those that are applied to a substrate.(Surface) Examples include: drafting, printing, and photography.

Six steps are required in the production of graphic communications items. They are:

1. Image design
2. Image generation
3. Image conversion
4. Image carrier preparation
5. Image transfer
6. Finishing
   (Transparency 3)

You should write these down. These will be discussed in more detail later.

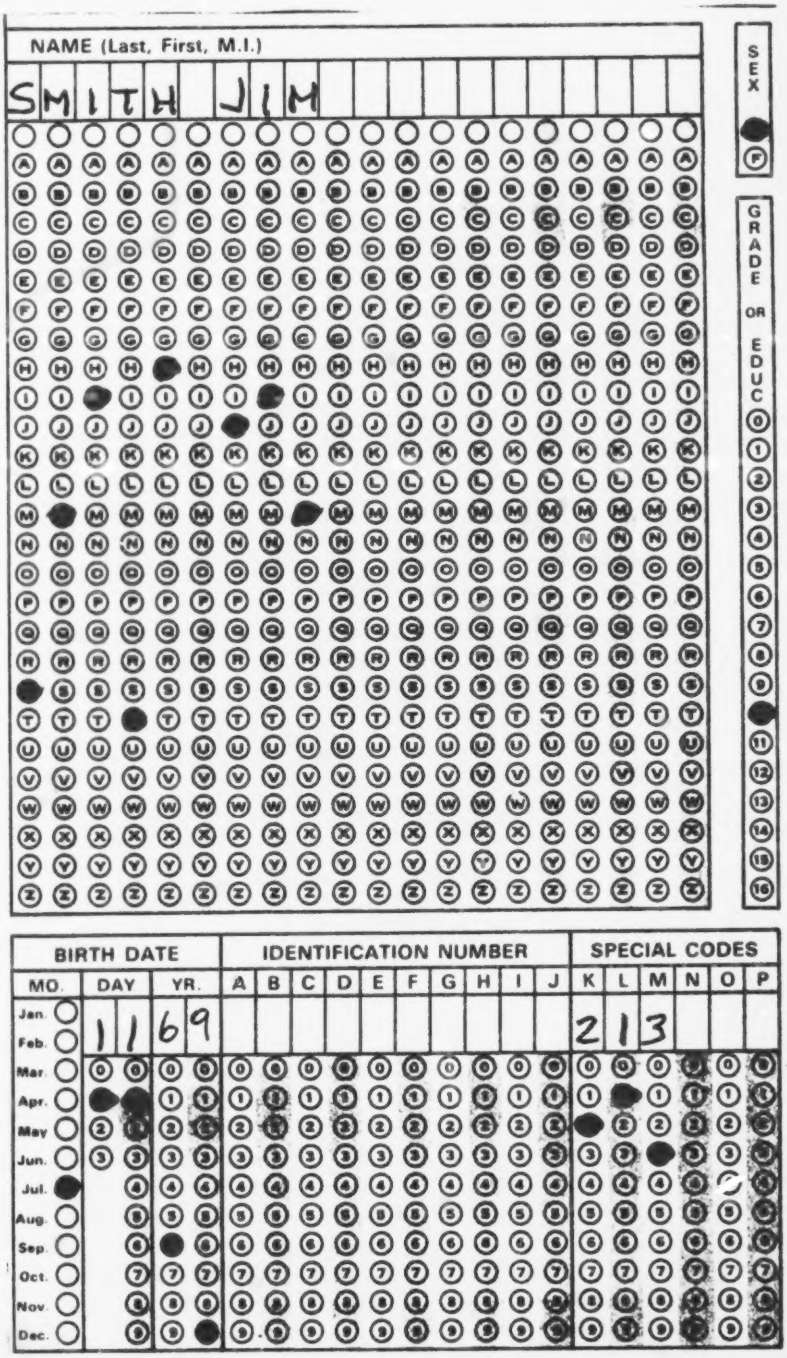
The major topic of this module is Image design. For the next three weeks we will be focusing on the tools, materials, procedures, and areas related to design.

The syllabus identifies the activities and grading procedures to be used as we cover image design. (Go over the Syllabus)

Tomorrow you will be introduced to design, sketching, and lab safety.

GRAPHIC COMMUNICATIONS MODULE
PRETEST

The purpose of this test is to determine what prior learning has occurred relevant to topics to be covered during the next three weeks. The scores for this test will be recorded but they will not be used when your grades are calculated.



NAME (Last, First, M.I.)
SMITH JIM

SEX
● M
○ F

GRADE OR EDUC
● 10

BIRTH DATE
MO. ● Jul.
DAY 11
YR. 69

IDENTIFICATION NUMBER
A B C D E F G H I J

SPECIAL CODES
K L M N O P
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Jan.
Feb.
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May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.

DIRECTIONS

Before you begin, make certain that you have the following:

1. Two sharpened #2 pencils
2. An answer sheet
3. A copy of the test

Complete the student information portion of the answer sheet as shown in the example on the right. The numbers that should be placed in the special codes section (K,L, & M) will be provided by your teacher.

You will have 25 minutes to take the test.

DO NOT TURN THIS PAGE UNTIL YOUR TEACHER TELLS YOU TO BEGIN.

GRAPHIC COMMUNICATIONS MODULE
PRETEST

1. The three primary units of the computer system are:
    a. the central processing unit, main computer storage, and output units
    b. input units, the processor unit, and output units
    c. input units, output units and the central processing unit
    d. input units, main computer storage, and output units

2. The first paper making machine was invented in France in about:
    a. 1798
    b. 1609
    c. 1066
    d. 1864
    e. none of the above

3. The rough layout is drawn _____ size relative to the final product.
    a. 3/4
    b. 1/4
    c. 1/2
    d. full

4. According to the dictionary, ALPHABET is the series of letters used in writing a language. The word is formed by joining the names for two symbols ALPHA and BETA. From what language did these letters originate?
    a. Algeria
    b. Phoenician
    c. Greek
    d. Roman
    e. Latin

5. In 1802 two men are credited with inventing photography. They are:
    a. Ben Franklin & Louis Daguerre
    b. Louis Daguerre & Pierre Fragonard
    c. Thomas Edison & Sam B. Jenkins
    d. Sir Humphrey Davy & Thomas Wedgwood
    e. none of the above

6. A comprehensive layout is best defined as a _______ of the finished product.
    a. master plan
    b. black and white copy
    c. half size drawing
    d. negative

7. A strong magnetic field:
    a. can erase floppy discs
    b. is in electrical appliances
    c. can be in a telephone
    d. all of the above
    e. none of the above

8. Of the topics listed below which is NOT considered part of the pre-layout planning sheet?
    a. all are correct
    b. approximate number of pages
    c. objective of the product
    d. layout format
    e. none are correct

9. When constructing thumbnail sketches, horizontal lines are used to represent:
    a. illustrations
    b. large letters
    c. small letters
    d. none of these

10. The first practical process which produced lasting photographic images in fine detail was called:
    a. Daguerreotypy
    b. Halftone photography
    c. Wet collodion negative photography
    d. Poloroid photography

11. If ink, oil, or other liquids are spilled on the floor, one should:
    a. walk around it carefully so as not to fall
    b. clean it up immediately
    c. clean it up at end of class
    d. leave it for the custodian

12. Although stencil printing has been around for centuries previously, Samuel Simon is generally credited with inventing true screen printing in England in about:
    a. 1850
    b. 1798
    c. 1747
    d. 1907
    e. none of the above

13. One purpose of a rough layout is to ___________ the thumbnail sketches.
    a. rethink
    b. do away with
    c. to force selection of
    d. help plan for

14. Of the items listed below which is NOT considered a design element?
    a. weight
    b. space
    c. line
    d. shape

15. The purpose of a computer system is to:
    a. keep track of airline reservations
    b. add numbers rapidly
    c. process data with such rapidity and reliability that human beings cannot perform the same operations in the same amount of time, leading to unemployment of clerical personnel
    d. accept data, process data, and as a result of the processing, produce output in the form of useful information

16. A computer:
    a. requires human intervention in order to perform its calculations
    b. is composed of mechanical and electrical components
    c. is a device which can perform computations without intervention by a human being
    d. requires flashing lights and a large console

17. A computer program:
    a. is a series of instructions stored in the input unit which specifies the processing operations to occur.
    b. controls the operations of input, process, and output which take place on a computer
    c. is written by people called computer operators
    d. contains instructions which the central processing unit arranges in the proper sequence and executes

18. Thumbnail sketches are defined as ___________.
    a. complex and very detailed drawings.
    b. refinement sketches.
    c. master plan sketches.
    d. simple idea sketches.

19. The comprehensive layout is generally drawn ____size relative to the final product.
    a. 1/4
    b. 1/2
    c. full
    d. 3/4

20. The printers Pica & Point system of measurement dates back about:
    a. 600 years
    b. 250 years
    c. 125 years
    d. 75 years
    e. 450 B.C.

21. Which of these are not temporary visual messages?
    a. wave, smile, nod
    b. frown, wink, tears
    c. letter, photo, sketch
    d. motion, or lack of motion
    e. none of the above

22. By the mid 1850's handwritten letters and hand-set copy declined in popularity. Printers feared their work should be taken over by a new implement. What was that implement?
    a. camera
    b. computer
    c. typewriter
    d. duplicator
    e. radio

23. It is generally accepted that the invention of _________ has made the craft of printing "the" most powerful influence upon the social scientific, and political history of humanity.
    a. photostatic copier
    b. paper
    c. fast drying production ink
    d. movable relief type
    e. the alphabet

24. The basic processing cycle on a computer system consists of:
    a. input, process, and store
    b. output, store, and logical operations
    c. input/output, process and arithmetic
    d. input, process and output

25. The primary purpose of the thumbnail sketch is to ____________.
    - a. design a complete layout
    - b. visually portray ideas
    - c. provide exact dimensions
    - d. all of these

26. The thumbnail sketch is usually drawn _______ size relative to the final product.
    - a. 1/4
    - b. 1/2
    - c. 3/4
    - d. full

27. Before using a machine, a pupil must:
    - a. pass a safety test
    - b. get permission from the teacher
    - c. check the machine for proper operating conditions
    - d. all of these

28. Johann Gutenberg is called the "Father" of modern printing because he
    - a. invented offset lithography
    - b. invented an inexpensive way to make paper
    - c. invented the printing press
    - d. invented movable type from clay

29. What ancient civilization invented the first alphabet to have characters that represented sounds?
    - a. Greeks
    - b. Romans
    - c. Phoenicians
    - d. Hitites
    - e. Samarians

30. When constructing thumbnail sketches the minimum number of sketches is _______.
    - a. 4-6
    - b. 0-2
    - c. 2-4
    - d. 10-12

31. The input operation on a computer system:
    - a. causes data to be placed in main computer storage
    - b. causes data to be moved from one locaton to another in main computer storage
    - c. causes the results of computer processing to be printed or displayed in a usable form
    - d. causes data to be prepared in a machine readable form for input to a computer system

32. A concept or group of concepts that extends or amplifies the ability to meet a human need.
    Ideas or rules created and controlled by humans to meet human needs.
    What word best fits these descriptions?
    - a. technique
    - b. applied science
    - c. technology
    - d. industry

33. What do we call drawings that carry meaning by attempting to replicate real objects?
    - a. ideographs
    - b. phonetics
    - c. graffiti
    - d. pictographs
    - e. comprehensive

34. If a pupil is not sure about the operation of a certain piece of equipment, he/she should:
    - a. read about it in the textbook
    - b. be checked out on it by the teacher
    - c. ask another pupil to help
    - d. learn to run it by watching others

35. A computer program
    - a. is stored on auxiliary storage when it must be executed.
    - b. contains instructions which direct the computer system to process data.
    - c. is stored on an input device until such time as it is going to be executed, at that time it is loaded onto auxiliary storage.
    - d. is stored in the central processing unit (CPU) and directs the CPU to process the data

36. Personal conversations with a machine operator is permissible:
    - a. only when discussing a problem
    - b. when the teacher is in the room
    - c. if absolutely necessary
    - d. never

37. Of the items below which is NOT found on a typical overlay sheet?
    - a. date of desired completion
    - b. sizes of type
    - c. colors of ink to be printed
    - d. number of finished copies

38. A mechanical layout is BEST defined as ___________.
    - a. a dummy layout
    - b. full color illustration
    - c. camera ready copy
    - d. all of these

39. Cutting tools should never be:
    - a. dull
    - b. carried in the pocket
    - c. left lying around the work area
    - d. all of these

40. "Horseplay" in the classroom:
    - a. is forbidden at all times
    - b. must be confined until after clean-up
    - c. should be limited to harmless practical jokes
    - d. is all right if work is not hampered

41. Samuel F. B. Morse inventor of telegraphy, was also an avid:
    a. lithographer
    b. photographer
    c. water polo player
    d. typesetter
    e. none of the above

42. A floppy disk or diskette:
    a. is so called because it is made from lightweight cardboard with data recorded through the use of holes
    b. is commonly used for computer output on large computer systems
    c. is oxide coated with data stored on it by electronic impulses
    d. contains data which can be read by the naked eye

43. When comparing the scientific method of problem solving to the design process. Stating the problem is equal to preparing the ______________.
    a. preplanning layout sheet
    b. thumbnail sketches
    c. rough layout
    d. comprehensive layout

44. What kind of printing did Alois Senefelder invent?
    a. Relief
    b. Gravure
    c. planographic
    d. Screen
    e. Xerox

45. When constructing thumbnail sketches ______________ are used to represent illustrations.
    a. simple area outlines
    b. detailed hand drawings
    c. stick figure drawings
    d. precise scale drawings

46. When comparing the scientific method of problem solving to the design process. Forming the hypothesis is equal to preparing the ________________.
    a. thumbnail sketches
    b. preplanning layout sheet
    c. rough layout
    d. comprehensive layout

47. Flammable liquids should be kept and stored in a metal safety can to:
    a. prevent evaporation
    b. reduce the fire hazard
    c. keep them out of the way
    d. make them easy to find

48. Relief printing is more than _______years old.
    a. 1000
    b. 2000
    c. 3000
    d. 4000
    e. 500

49. Which of the following BEST describes a comprehensive layout?
    a. shows all elements in correct size and color
    b. gives the major elements
    c. shows major parts of the job
    d. Use design principles to illustrate an idea.

50. Paper was invented by the:
    a. Babylonians
    b. Chinese
    c. English
    d. Egyptians
    e. Americans

LESSON PLAN - DAY 2

Title: "Introduction to lab safety, design and sketching"

OBJECTIVES

1. Generate within each student positive attitude toward equipment operation and safe operating procedures.
2. The students will be able to express themselves in written form. form supporting the need for a well planned design using proper grammer.
3. The student will be able to draw thumbnail sketches using the proper symbols.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

1. No. 2 pencils
2. Paper (8½ x 11)

HANDOUTS AND WORKSHEETS

1. Assignment sheet #1
2. Safety Rules
3. Thumbnail note sheet

INTRODUCTION

1. Safety rules (go over)
2. Have you ever wondered why our automobiles have the steering wheels on the left side? (Can you explain why?)
3. Have you ever noticed that most houses have the kitchen, bathroom, utility room very near each other? (Can you explain why?)
4. Universal signs were designed to avoid the language barrier, the man and woman on restrooms are one example. (Can you think of any others?)

CONTENT OUTLINE AND PROCEDURE

I. Design arranging parts of a product to best serve the maker as well as the user.

II. Design considerations
   a. what the product should do
   b. who will use it

With todays ultra-compact and highly technical products, it is very important that design people consider all ideas and possibilities to arrive at a desirable and usable product. Examples: (1) compact calculators, (2) wrist watch TV, (3) compact cars, (4) auto engines, (5) on the scene TV cameras, (6) household video recorders, (7) obtain other class members, (8) telephone answering machines.

SUMMARY AND FUTURE TOPICS

I. Safety Summary: These rules are intended to alert the student to the fact that effective safety education leads to attitudes that result in safe work practices in the lab. But more important is the attitude of safety becomes more than the practices in the lab, but an attitude of safety beyond the lab which will last a lifetime.

II. Without a well-planned and completely designed product problems may arise in making use of the item. These problems may be so severe that the product may not be makeable or the intended customer may never buy it, causing the producer to lose a lot of money.

III. Future Topics: Tomorrow we will analyze your homework and discuss the principles of design.

ASSIGNMENT

1. Hand out thumbnail sketch note sheet
2. Develop (4-6) thumbnail sketch of a billboard with a single product of your choice, use 8½ x 11 sheets, pencil, and erasers. Will be critiqued by the class next time.

REVIEW QUESTIONS AND VOCABULARY

A. Why is design important?
B. Design: relating elements either similar or contrasting, and arranging them visually to create a single effect.
C. Thumbnail sketch - simple idea sketch with little detail
D. Technology - any concept (or group of concepts) that extends or amplifies the ability to meet a human need.

REFERENCES

Safety Guide, McCombs Jr. High School, Des Moines, Iowa 50315
Industrial Arts Safety Guide, Cedar Rapids Community Schools, Cedar Rapids, IA
Comprehensive "Graphic Arts", Ervin A Dennis, John D. Jenkins

GENERAL SAFETY

Accident prevention is up to each individual. There are certain basic rules of safe behavior that a person should make a part of his/her daily routine. These rules involve attitudes toward fellow workers as well as attitudes toward the task at hand. People with poor job attitudes are those who most frequently have accidents.

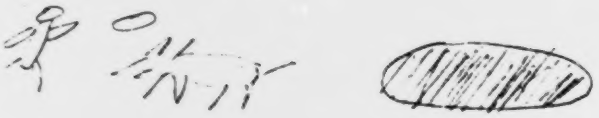
1. Keep loose paper and other materials from accumulating on the floor.
2. Turn all lights on while work is being done in the laboratory. Good illumination is essential for safe working conditions.
3. Help to maintain a low noise level in the laboratory. Unnecessary talking and laughter should be avoided.
4. Safety cans have been provided for solvents; therefore use the containers in the proper way. Keep lids in place except, of course, when contents are being added or removed.
5. Solvent soaked rags must be placed in metal safety cans. Never discard a solvent saturated rag in the waste basket - fire may result.
6. Keep flammable cleaning solvents away from intense heat or potential sparks.
7. Never use any solvents with a flash point of less than 100° F.
8. Keep all solvents in labeled safety cans.
9. Identify chemicals by the label or by asking the instructor.
10. Make certain that the room is ventilated before using any volatile chemicals.
11. Wash hands immediately after using any chemicals.
12. Do not tilt chairs.
13. Do not lean on glass tracing or make-up tables.
14. Dry hands before touching any electrical switches, plug or machine equipment.
15. Learn the location of the main switches for each machine so that it can be turned off quickly in case of emergency.
16. Do not permit oil or debris to accumulate on the floor around any machine.
17. Exercise care while opening the tight covers of ink cans or other containers.

THUMBNAIL SKETCH

Thumbnail sketches are simple ideas sketches which help the designer. These sketches have three primary purposes, they: (1) graphically preserve ideas, (2) visually portray ideas, and (3) compare two or more ideas visually.

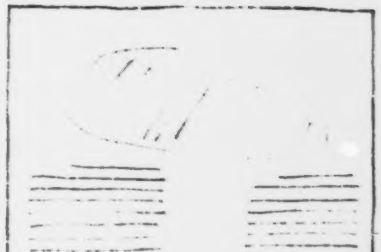
Thumbnail sketches are ¼ smaller than the finished product, but are proportionally the same. Many types of tools can be used in sketching, but usually paper and #2 or HB pencils are standard. Thumbnail's give the designer a chance to create several possible solutions, without taking time for details. Pictures or halftones are usually shown in outline or gray shaded area. Small print or copy is indicated by parallel or horizontal lines. Headlines or bold print are shown with zigzag or vertical lines.

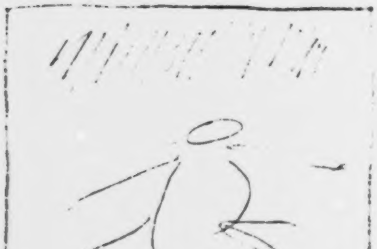
Examples Drawings & Photograph



small print or copy

Headlines & Bold Print





Thumbnail Sketch Note Sheet

Thumbnail Sketch

Three Primary Purposes

Size

Advantage

Examples

Assignment #1

Develop 4-6 thumbnail sketches of a billboard for a single product of your choice. Use 8½ x 11 sheets, pencil and eraser. Your sketches will be critiqued by the class next time we meet. Do not pick a product that may be offensive or obscene to your classmates.

LESSON PLAN - DAY 3

Title: "Principles of Design"

OBJECTIVES

The student will be able to:
- a. define five design elements with 80% accuracy
- b. list the design elements with 80% accuracy
- c. identify and recommend possible changes of design elements found in an existing design

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

1. Sketching materials
2. Good imagination
3. Transparency markers
4. Overhead projector
5. Old newspapers (to help students with Assignment #2)
6. Transparency masters covering:
    - a. page proportion
    - b. contrast
    - c. unity
    - d. rhythm
    - e. blank transparency master
    - f. balance

HANDOUTS & WORKSHEETS

Skeletal outline of "Design Elements & Principles"
Assignment for assignment #2 to be passed out during step #7 of lesson plan

INTRODUCTION

1. Collect students Thumbnail Sketches
   Quickly check for and note the following:
    - a. Number of students who turn them in
    - b. Those who followed directions
    - c. Those that reflect the design principles and which specify principles
    - d. All sketches illustrates same idea
2. Class discussion using opaque projector
3. Many of your thumbnail sketches reflect the concepts and terms we will be learning about today.

CONTENT OUTLINE	PROCEDURE
I. Designing	Relating elements either similar or contrasting and arranging them to visually create a single effect.
II. Two Divisions of Design	
A. Design elements	Define the basic components used in creating a graphic image.
1. Space	Area we are allowed to work with (page size). Without space we would have no reason for design.
2. Line	Major item for image generation. Lines provide us a method for generating images

3. Shape	Define combinatin of lines. Shape is generated by combining lines.
4. Form	Orderly method of arranging elements. Form is achieved by arranging shapes in an orderly fashion.
5. Color	Visual perception that enables one to differentiate otherwise identical object, also affects emotion conveyed by the design. Warm colors: red, yellow, orange, colors which relate to fire, the sun, and blood.
NOTE: To describe below items use transparencies for each topic	
B. Design Principles	Define guidelines used in the arrangement of elements in a design.
1. Page Proportion	Typical base proportions: File cards: 3x5, 4x6, 5x8 Photographic: 5x7, 8x10; Drafting, Graphic Arts, & Business: 8½ x 11. Page proportion is select to provide function and attraction of the audience. Size is chosen with two major considerations: 1. amount of copy to be placed on the page, 2. the intended use of the product.
2. Balance	
a. formal	All elements centered horizontal or vertical about the mathematical center line, equal amounts of each major element on either side of the center line. Used by business's who want to convey the feeling of security (banks, insurance companies, etc.).
b. informal	Definition: elements unequally placed but still appear balanced. Used by most clients, considered the more modern design princple of balance.
3. Contrast	Definition: accenting of a certain element, to set it apart from other elements in that layout. "All display is no display" If all the elements of the page are large, bold, underlined, or in color, they would not indicate change.
4. Unity	Definition: ties all elements together to provide "oneness" or a look of belonging for all elements. When considering unity eye movement must also be considered. Eye movement is obtained with good unity. In the U.S.A., the eye enters the page at the upper left corner, moves to the right and down to the right hand corner. Because that is the way we are taught to read and write.
5. Rhythm	Repetition of elements to create an artistic effect. Layouts with many illustrations must be dealt with carefully. A tested and proven method is that of forming the layout after one of the following letters: C,U,T,Y,O, and S. The letter form appear on the layouts, they are not drawn, but illustrations and display (large) lettering are arranged to form the desired outline in the layout. The letter "S" is considered by designers to be the most pleasing arrangement. It Swings the readers eye down the page, giving the layout a swinging movement or rhythm.

SUMMARY AND FUTURE TOPICS

I. Remember the definitions of design elements and design principles. Also remember how to apply those elements and principles.

II. Tomorrow we will cover the design process. We will have a slide series to help us understand the application and steps involved as the design process is used in an actual business.

ASSIGNMENT

Between now and tomorrow you are to find a newspaper advertisment (may be from an old paper), clip it out, and analyze it according to the following points:

a. Point out, in writing, how each design elements is used and which principles are applied.
b. List at least five good points displayed and recommend at least five improvements using proper terms from today's class discussion and your notes.

REVIEW QUESTIONS AND VOCABULARY

1. What is the definition of design elements?
2. Are you able to list the five design elements (give examples of each)?
3. Can you define design principles?
4. Are you able to list the six design principles and give examples of each?

Vocabulary: Designing, Design Elements, Design Principles, Space, Line, Shape, Form, Color, Page Proportion, Formal Balance, Informal Balance, Contrast, Unity, Rhythm

REFERENCES

"Graphic Layout and Design", by Gerald A Silver, published by Delmar Publishers Inc., Albany, New York
"Comprehensive Graphic Arts", by Dennis & Jenkins, published Bobbs-Merrill
"Color Manual for Artists:, Arthur L. Guptill

Students Skeletal Outline for Day 3

Objectives for Day 3 Lesson

The student will be able to:

1. Define the five design elements with 80% accuracy
2. List the design elements with 80% accuracy

I. Designing (definition):

II. Divisions of Design

A. Design elements (definition):

1. Space

2. Line

3. Shape

4. Form

5. Color

B. Design Principles (definition):

1. Page proportion

2. Balance
    a. informal balance

    b. formal balance

3. Contrast

4. Unity

5. Rhythm

STUDENT'S ASSIGNMENT SHEET FOR
ASSIGNMENT #2
"Improvement of a Newspaper Advertisement"

Objectives:

The student will be able to identify and recommend possible changes aimed at improving an existing design.

I. Clip out a newspaper advertisement (may be from an old newspaper)

II. Analyze it according to the following points:

  A. Point out, in writing, how each design element is used and which principles are applied.

  B. List at least three good design points displayed.

  C. Recommend at least three improvements.

Be sure to express the above points in design terms from todays lesson. Your assignment will be evaluated according to the above points, also keep your work neat and clean. Be sure to use proper grammar and correct spelling.

INSTRUCTOR'S EVALUATION SHEET
FOR ASSIGNMENT #2
"Improvement of a Newspaper Advertisement"

The student:	Possible Points	Points Earned
1. Pointed out how each design was used.	3	______
2. Pointed out which principles where applied.	4	______
3. Identified good design points.	4	______
4. Recommended three improvements.	4	______
5. The assignment was neatly done.	4	______
6. Used complete sentences, proper grammar, and correct spelling.	6	______
Total Possible	(25)	
Total Earned		______

LESSON PLAN-DAY 4

Title: "Design Procedures"

OBJECTIVES

The student will be able to:

1. List the topics needed to complete a pre-layout planning sheet with 80% accuracy
2. Define a thumbnail sketch correctly.
3. Identify the three components of a thumbnail sketch.
4. List the primary purposes for thumbnail sketches correctly.
5. To state the size of a thumbnail sketch, relative to the finished product correctly.
6. To define a rough layout correctly.
7. State the primary purposes of a rough layout correctly.
8. State the size of a rough layout, relative to the final product correctly.
9. Define a comprehensive correctly.
10. State the three primary purposes of a comprehensive layout with 100% accuracy.
11. To state the size of a comprehensive layout, relative to the size of the final product.

TOOLS, EQUIPMENT, AUDIO VISUALS

1. Overhead projector
2. Slide projector
3. Script for slide series
4. Transparencies of "The Design Process"
5. Slide series of the design process of the Graphics Corporation, Des Moines, Iowa.

HANDOUTS AND WORKSHEETS

1. Sheet comparing the scientific method to the Design Process
2. Skeletal outline for today's lesson

INTRODUCTION

Up to today's lesson we have been discussing safety and the need for a logical designing and a structured planning of a product, you have also had homework to help you gain an understanding of some of the problems designers confront daily. For example: How can I best show the clients product to the public. Today's design procedure lesson will provide you with a proven method used by many designers. This method relates very closely to the scientific method of problem solving, which you may have used before. Our problem solving method is often called a design process.

CONTENT OUTLINE	PROCEDURE
I. Prelayout Planning Sheet	Helps form original ideas of the client
A. Twelve questions to guide the designers	1. Objective of the product. What is the purpose of the product. 2. Designated group: who will use it? (students, adults, special group, or everyone) 3. Personality of the product. Sophisticated, funny, gaudy, dignified. 4. Style of finished product: will there be photos or all written, some line drawings, cartoons or a little of each? 5. Layout format: booklet, folder, bulletin poster, one sheet or complete book 6. Finished size 7. Number of pages 8. Total number of copies 9. Finishing & binding needs. Will it be folded, stapled, or bound? 10. Layouts needed: does the client need total layout package or just revise a product already designed. 11. Estimate of hours for completion 12. Approximately when will the product be ready for the client.
B. Equivalent scientific method would be stating the problem	
II. Thumbnail Sketches	*Use Transparency for this section during discussion
A. Definition	Simple idea sketches which provide many (4-6) ideas
B. Primary Purposes	1. Graphically preserve or store ideas 2. Visually portray ideas 3. Compare ideas visually
C. Size	1/4 of the finished product size
D. Scientific Method	Forming the hypothesis ties to this step. We are starting to propose a solution
III. Rough Layout	*Use transparency for this section during discussion
A. Definition	Improve, refine or combine thumbnail sketches
B. Primary Purposes	Beginning to refine our many ideas from the thumbnails. Provide a tangible (able to be seen & touched) item that can be studied by the artist and client and it also allows for changes.
C. Size	Full size relative to the final product
D. Scientific Method	Equal to the observing and experimenting stage.
IV. Comprehensive Layout	*Use transparency for this section during discussion
A. Definition	Accurate representation of the finished product.

CONTENT OUTLINE	PROCEDURE
B. Primary Purposes	1. Shows correct location, size and colors of all elements to be used on the final product. 2. Allows the designer and client to see the finished product. 3. Guides specialists who produce the final product.
C. Size	Full Finished size
D. Scientific Method	Equal to interpreting the data
IV. Slide Series of material from Graphics Corporation	Script included

SUMMARY AND FUTURE TOPICS

Summary: today's lesson should help tie together past topics to help give you a better understanding of the need of a well planned design as well as the tasks which face many designers.

Future Topics: Tomorrow we will be doing three main activities.
1. Discussion of the remaining steps of the design process.
2. Demonstration of tools used by designers to prepare layouts.
3. Quiz covering the objectives up to that time.

ASSIGNMENTS

Study given handouts and class notes with the objectives to prepare for the quiz tomorrow.

REVIEW QUESTIONS AND VOCABULARY

1. Can you at this point fulfill all the safety items, objectives, and vocabulary we have talked about?

Vocabulary: prelayout planning sheet, thumbnail sketches, rough layout, comprehensive layout, scientific method, design process

REFERENCES

"Comprehensive Graphic Arts", Dennis & Jenkins
"Graphic Layout & Design", Silver
Scientific Method of Problem Solving, Encyclopedia Britanica

SCIENTIFIC METHOD OF PROBLEM SOLVING AS IT RELATES TO THE DESIGN PROCESS

Stating the problem
Forming the hypothesis
Observing and Experimenting
Interpreting the data
Drawing Conclusions

The scientific method described above involves mainly inductive logic. This kind of logic requires repeated observation of an experiment or of an event. From observing many different examples the scientist can draw a general conclusion. But scientists may also use deductive logic. In using deductive logic, a scientist reasons from known scientific principles or rules to draw a conclusion relating to a specific case. The accuracy of a conclusion reached by deductive logic depends on the accuracy of the principle and rules used.

SCIENTIFIC METHOD	ENGINEERING DESIGN PROCESS	GRAPHIC COMMUNICATION
1. Stating the Problem	Ascertain the Problem (Brainstorming)	Information Gathering Prelayout Planning (Basis for the Design Process)
2. Forming the Hypothesis	Propose Solution (Thumbnail)	Rough-out Ideas (Putting Information to Work)
3. Observing and Experimenting	Develop and test the Chosen Solution (Rough Layout)	Image Making (Intuitive Decision Making & Creativity)
4. Interpreting the Data	Decide on the Solution (Comprehensive)	Presentation (Fine Tuning the Concepts)
5. Drawing Conclusions	Produce drawing and Specification (Paste-up)	Choosing Illustrators (Photographer)

SKELETAL OUTLINE - DAY 4

I. Prelayout Planning Sheet

  A. Twelve Questions

  B. Scientfic Method

II. Thumbnail Sketches

  A. Definition

  B. Purpose

  C. Size

  D. Scientific Method

III. Rough Layout

  A. Definition

  B. Primary Purpose

  C. Size

  D. Scientific method

IV. Comprehensive Layout

  A. Definition

  B. Primary Purpose

  C. Size

  D. Scientific Method

LESSON PLAN - DAY 5

Title: "Design Process" continued

OBJECTIVES

The student will be able to:

1. List the seven items found on a typical overlay sheet to acceptable standards.
2. Correctly define a mechanical layout.
3. State in writing when a mechanical layout is required to complete the design process
4. To compare the scientific method of problem solving and the design process to acceptable standards.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

Required Items: (Tools)
1. T-square
2. 30°-60° triangle
3. 45°-90° triangle
4. Rubber cement or invisible transparent tape
5. Exacto type knife
7. Non-photo blue pencils
8. Plain white 8½ x 11 paper
9. Compass

Optional items: (Tools)
1. Drafting machine
2. Waxer
3. Burnisher or Brayer
4. Transfer letter
5. Clip art
6. Boarder tapes
7. Circle template

Equipment:
1. Light table, drafting table or drawing board
2. Overhead projector

Audio Visual:
1. Transparencies from comprehensive with included overlay

HANDOUTS AND WORKSHEETS

1. Skeletal outline of overlay sheet and mechanical layout

INTRODUCTION

Yesterday we covered the four major steps of the design process. Today we will have three topics to complete.

1. Items which assist the production personnel.
2. Demonstration by instructor of developing a rough layout.
3. Quiz over safety, design elements.

CONTENT OUTLINE	PROCEDURE
Two items included which assist the production personnel	
A. Overlay sheet	*Use transparency for this item
1. Definition	Contains all information necessary to complete the finished product.
2. Items included	1. Kind, size, and style of type for each element 2. Type position if specific margins or line lengths are desired. 3. Specific information relating to illustrations and/or photos. (i.e. where camera ready copy is available & where the photos can be obtained 4. Colors or colors of ink. If single color note only one. If several, pinpoint them to various elements of the job. 5. Indicate paper as to finish, weight, & size. 6. Number of finished copies desired.
B. Mechanical Layout	
1. Definition	Known as "Camera-ready copy"
2. When Needed	Only when product is multi-colored.
3. Number needed	One layout for each color, for photo conversion
	End lecture - start class demonstration of: developing rough layout

I. Gather all required materials and any desired optional items.

II. From your past experiences and information provided, work up thumbnails to show class. Using materials identify and explain while generating an adequate rough layout for students. Watch your time closely to allow enough time to administer quiz. (10-15 minutes).

SUMMARY AND FUTURE TOPICS

With today's information and past lessons, we have covered the complete scope of the design process. We will soon be applying all the topics learned so far so each of you (or each group) can generate your own design process.

Tomorrow we will begin study of the history of graphic communications. We will soon begin studying the computer for design applications.

ASSIGNMENT

None for this lesson

REVIEW QUESTIONS AND VOCABULARY

From today's lesson, are you able to define and explain in writing the use of an overlay sheet? Can you state the common name of the mechanical layout? Are you able to state when a mechanical layout is needed?

Vocabulary: All to date, as well as the following:
1. Mechanical layout
2. Overlay sheet

REFERENCES

"Comprehensive Graphic Arts", Dennis & Jenkins
"Graphic Layout & Design", Silver

DAY 5

(Student Handout)
"Skeletal Outline of Overlay Sheet & Mechanical Layout"

Items which assist the production personnel

A. Overlay Sheet

1. Definition

2. Items included:

a.

b.

c.

d.

e.

f.

B. Mechanical Layout

1. Definition

2. When needed:

3. Number needed:

QUIZ ITEMS - QUIZ I

1. Keep _______________ cleaning liquids away from intense heat or potential sparks.

2. Keep all solvents in ___________ safety cans.

3. Always dry the hands before touching any _________ switches, plugs or machine equipment.

4. In case of accident, however slight, tell the __________ immediately.

5. To avoid ___________, remove oil, grease and other debris from the floor.

6. The use of one of the following should be avoided if possible:

   a. gasoline
   b. kerosene
   c. motor oil
   d. solvents

7. Chemical containers should always be:

   a. painted
   b. plastic
   c. labeled
   d. locked up

8. Chemicals should always be stored:

   a. horizontally
   b. on low shelf
   c. at waist level
   d. on metal shelves

9. Safety must be practiced by:

   a. those who feel the responsibility
   b. everyone, all the time
   c. equipment operators
   d. all personnel excepting the foreman

10. One of the following is required in the school shop:

    a. bandaids
    b. ashtrays
    c. fire extinguisher
    d. water fountain

11. Keeping the shop floor in safe working condition is the responsibility of:

    a. the custodian
    b. the teacher
    c. the teacher and pupils
    d. all of these

12. A pupil should not meddle with machinery which does not concern him/her because:

    a. the machinery might be damaged
    b. someone's work in the machine might be damaged
    c. he/she might cause injury to someone
    d. it might cause trouble for the one meddling

13. Identify the contents of bottles by:

    a. taste
    b. smell
    c. reading the label
    d. asking another pupil

14. Pupils should be especially alert to danger from accidents when:

    a. using unfamiliar tools or equipment
    b. trying to hurry to complete a project
    c. the teacher is out of the room
    d. all of these are taking place

15. A rought layout is BEST defined as a (an) ____________ of thumbnail sketches.

    a. improvment
    b. total change
    c. complete opposite
    d. optional part

16. Combustible materials such as solvents, type cleaners, rubber cement, etc. should be:

    a. stored in fireproof containers
    b. used only in well-ventilated areas
    c. kept away from fire and sparks
    d. all of these

17. When constructing thumbnail sketches, vertical lines are used to represent:

    a. large letters
    b. small letters
    c. illustrations
    d. none of these

18. Turning on a switch for another person may:

    a. cause serious injury to the other person
    b. be a big help
    c. blow a fuse
    d. be a good thing to do

19. A mechanical layout is required when the ___________.

    a. product is more than one color
    b. designer has nothing else to do
    c. client demands one
    d. product is more than one page

20. Oily waste and rags should always be:

    a. placed in the waste basket
    b. rolled in a tight bundle
    c. placed in a metal self-closing can
    d. left out for the next person to use

21. Distracting a fellow worker's attention for a moment:

    a. can cause an accident
    b. is permissible when the teacher is out of the room
    c. is permissible when the teacher is in the room
    d. can keep him alert

LESSON PLAN - DAY 6

Title: "History of Graphic Communications"

OBJECTIVES

After completing this assignment and participating in the related class activities the student:

1. Will be able to use the library to locate material on a specific topic.
2. Will be able to list a minimum of 6 major developments in human communications as related to the graphic arts.
3. Will be able to discuss the effects of these developments on graphic arts and their impact on society then and now.
4. Will be able to discuss the impact of the Graphic Arts on communication in the past and present, and also future trends.
5. Will be able to relate the history of the Graphic Arts to history in general.
6. Will practice the constructive criticism and evaluation of their peers work orally and in writing.
7. Will present a 3-5 minute oral report on a specified subject to the class.
8. Will be able to pass an objective quiz over this material - 85% correct.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

1. Slide projector or overhead projector
2. Slides or transparencies

HANDOUTS AND WORKSHEETS

1. Timeline
2. Assignment sheet
3. Evaluation sheet

INTRODUCTION

Return and briefly go over the quiz.

Method of presentation lecture with student discussion.

We have been engaged in a study of the techniques, tools and materials used in the graphic arts. At this point it would be helpful to take a trip into time and locate beginnings of graphic arts communication.

Picture yourself and your friends as a tribe of primitive Neanderthals, the date is around 35,000 B.C. We are talking about pre-historic times here friends. What do you seriously imagine life would be like? How would you occupy your time? What needs would you and your friends have? Would you have a need for communication? (yes) What means, you have only the most fundamental beginnings of language?

Cave paintings, drawing in the sand could have been used to communicate with each other. These are called PICTOGRAPHS, pictures that attempt to record things much like a photograph does today. Thousands of years later languages have developed, and civilization is starting to flourish. With these changes there was a need for a more efficient way to communicate and record messages.

In about 1200 B.C., that's about 33,000 years after our Neanderthals, the limitations of the pictograph system were becoming something of a strain.

So a group of traders in Phoenicia (Syria, where's that?) tried to simplify the pictures and use them to represent ideas instead of just an actual object. These are called IDEOGRAPHS. One example you have all heard of are Egyptian hieroglyphics. You may also know that the Japanese and Chinese use this type of symbol system.

The limitations of ideographs (what are these?) led the Phoenicians to develop a system where symbols represented sounds (900 B.C. or so). These symbols could be assembled into words. This is the beginning of the Phonetic alphabet. Which is the basis for most written languages. Because the Phoenicians were traders, they came into contact with many other civilizations, among them the Greeks. The Greeks adopted the Phoenicians symbols, but added five vowels and changed the names of the aleph and beta to Alpha & Beta. This centuries later became our Alphabet.

Around 300 B.C. the Romans borrowed the Greek alphabet and like many people when they borrow something and find it not quite to their liking, they modified it to suit their needs. They used 13 of the letters as is, changed 8 and added F and Q which gave them 23 letters - the Latin alphabet. This was used unchanged for almost 1200 years. About 1000 years ago the letter U was added and two V's were stuck together to make a W (double U). Finally, in the mid to late 1400's the J was added to give us the 26 letters we use today.

This phonetic alphabet had tremendous advantages over the previous systems. Hence its evolution and current use today.

However, if you go back to 900 B.C. we find that the communication system still had limitations that continued to create new needs (some of them lead to the evolution of our current alphabet). What were these needs, and how were they met?

CONTENT OUTLINE AND PROCEDURES

I. Development of Graphic Symbols.

   A. Pictographs (def.) drawings that carry meaning by attempting to look like real objects.
      1. Advantages:
         a. easy to understand
      2. Limitations
         a. one to one relationship with reality
         b. difficult to communicate complex ideas
         c. impossible to communicate abstract ideas (good, bad, love, hate)

   B. Ideographs (def.) Simple drawings used to symbolize ideas or concepts
      1. Advantages:
         a. complex and abstract ideas can be represented
      2. Limitations
         a. system is unwieldy, the number of symbols
         b. difficult to understand

   C. Phonetic Symbols (def.) Symbol represents a sound, symbols may be grouped to form words.
      1. Advantages:
         a. one finite set of symbols can be used to write an almost infinite set of words

II. Time Line

A. Important Highlights
1. Paper Ts' ai Lun
2. Roman Alphabet
3. Reproductive processes
    A. relief printing - Chinese, Gutenburg
    B. stencil printing
    C. Intaglio
    D. Lithographic - Senefelder 1796
4. Papermaking machines. 1798
5. Photography. 1802
6. Powered presses. 1811
7. Rotary presses. 1847
8. Typesetting machines (Mergenthaler). 1880
9. Telephone (Alexander G. Bell). 1876
10. Telegraph (S.F.B. Morse). 1840
11. Photo-Offset printing
12. Photo typesetting
13. Communications satellites
14. Computer generated images

PROCEDURE OUTLINE

I. Introduction - Lecture/Discussion/Question & Answer
    A. Script
    B. Illustrations (Transparencies) of Alpha and Beta and Alphabet evolution.

II. Time Line. Use Chalk board or overhead with transparencies with overlays.
    A. Pass out time lines to students.
    Using the provided time line discuss with the students the following questions:
        1. Which items on the time line (in the student's opinions), are the most important?
        2. Why do you think so?
        3. How did this development change the limitations of communication?
        4. What new needs did each of these developments create?
        5. How and when and by whom were these needs met?
        6. Is the time line complete (obviously not)?
        7. What would you include that is not already on it?
        8. Why?
        9. Explain why changes and developments in communication sometimes took hundreds of years in the beginning of the time line and sometimes only days at the end of it?
        10. What impact will this have on the future?
        11. Do you think these changes in technology and communication will be positive or negative?
        12. What conclusions can you draw from this?

SUMMARY AND FUTURE TOPICS

Tomorrows topic - Introduction to Microcomputers

ASSIGNMENT

1. Pass out assignment sheet.
2. Have students (individual or small groups of 2-3) pick a topic from time line (or assign them as needed).
3. Explain the requirements.
4. Set the due date.

REVIEW QUESTIONS AND VOCABULARY

Vocabulary:
- Alphabet
- Phonetic
- Pictogram
- Ideogram
- Relief Printing
- Intaglio
- Gravure
- Lithographic
- Screen Printing
- Offset Printing
- Continuous Tone
- Halftone

REFERENCES

DAY 6

ASSIGNMENT SHEET

Rationale:

The purpose of this assignment to challenge you and provide the opportunity to participate in a part of this course normally covered in a less than thrilling lecture. Lectures by their very nature provide little or no challenge (except to stay awake) and even less opportunity for you to participate. Participation is important, not only are you graded on it, but also without your personal participation in the learning process you learn nothing.

Objectives:

After completing this assignment and participating in the other related class activities you should (from lesson plan activities):

1. Be able to use the library to locate materials on a specific topic.
2. Be able to list a minimum of 6 major developments in human communications as related to the graphic arts.
3. Be able to discuss the effects of these developments on graphic arts and their impact on society then and now.
4. Be able to discuss the impact of the Graphic Arts on communication in the past and present, and also future trends.
5. Be able to relate the history of the Graphic Arts to history in general
6. Practice the constructive criticism and evaluation of their peers work orally and in writing.
7. Present a 3-5 minute oral report on a specified subject to the class.
8. Be able to pass an objective quiz over this material - 85% correct.

Assignment:

You (or your group) will prepare a short oral report to be presented to the class on an important technological development in the history of graphic communications.

Assignment Requirements:

1. 4-6 minute oral presentation to the class
2. Bibliography - absolute minimum three sources. (Recommended sources - Maximum 1 encyclopedia, minimum 1 book, minimum 1 periodical)
3. Outline and notes, and or actual script. Outline to be turned in before presentation.
4. In addition to answering who, where, what and when you should also address the following questions:

    a. It is said "necessity is the mother of invention", if so what were the needs (necessity) that lead to this particular discovery or invention?
    b. What effects have this discovery or invention had on society in general? on graphic communications?
    c. Did the discovery or invention pave the way for any further new innovations or developments?
    d. Existing technology imposes certain limitations on any given process. Did this discovery or invention change those limits? If so, how?

   e. What can you tell us about the inventor(s) as a person that will make them more real to us?

5. The written portions of this assignment will be typed or neatly written in black or blue ink. Sheets torn out of a spiral notebook will not be accepted.
6. The use of at least one visual aid is required. You may use more if it's appropriate.
7. The punctuation, spelling, and grammar used in the report should not seriously strain the accepted limits of conventional usage.

EVALUATION SHEET/WRITTEN REPORT

		Dismal 0	Poor 1	2	3	4	Outstanding 5
OUTLINE & SCRIPT							
1.	A. Is it typed or neatly written in black or blue ink?	0	1	2	3	4	5
	B. Is it on clean neat paper (not torn from spiral notebook)?	0	1	2	3	4	5
2.	A. Is the punctuation acceptable?	0	1	2	3	4	5
	B. Is the spelling acceptable or does it strain your imagination?	0	1	2	3	4	5
	C. Is the grammar acceptable?	0	1	2	3	4	5
3.	Good use of technical vocabulary - appropriate (specific to the subject)	0	1	2	3	4	5
4.	Is the outline a good guide to the oral report presented in class?	0	1	2	3	4	5
5.	Did the written material address the questions on the assignment sheet?	0	1	2	3	4	5
6.	Was the information in the report accurate?	0	1	2	3	4	5
BIBLIOGRAPHY							
7.	Is the required number of sources listed (3)?	0	1	2	3	4	5
	Is all the essential information for the source listed?	0	1	2	3	4	5
8.	Are the listed sources appropriate for the kind of information being sought?	0	1	2	3	4	5
VISUAL AIDS							
9.	Was it neatly done and used in such a way the whole class benefited (everyone could see it)?	0	1	2	3	4	5
10.	Did the student show thought and care in the work presented and turned in?	0	1	2	3	4	5

TOTAL POINTS _______/50

Additional Comments:

Name (Presenter) ____________________

Evaluator ____________________

Period ____________________

EVALUATION SHEET FOR ORAL REPORT

	Dismal 0	Poor 1	2	3	4	Outstanding 5
1. Did the presentation stay within the specified time requirements?	0	1	2	3	4	5
2. Did the presentor appear to be familiar with the material? (In other words have they done their homework or was the report made up during passing time between classes?)	0	1	2	3	4	5
3. Did the visual aids enhance the presentation?	0	1	2	3	4	5
4. Did the presentor address all the questions posed on the assignments sheet?	0	1	2	3	4	5
5. Did the presentor leave you with more insight on the subject than you had before?	0	1	2	3	4	5
6. Could you hear without straining?	0	1	2	3	4	5
7. Did the report proceed at a comfortable pace, neither too fast nor too slow?	0	1	2	3	4	5
8. Did the presentation proceed in an organized fashion?	0	1	2	3	4	5
9. Did the speaker make eye contact with you, with the rest of the class, or was their nose buried in their notes?	0	1	2	3	4	5
10. Overall how would you rate this presentation?	0	1	2	3	4	5

TOTAL POINTS ________

COMMENTS:

Name____________________

Period__________________

GROUP SELF EVALUATION SHEET

1. What were your individual responsibilities for this assignment?

2. What were the responsibilities of the other members of of your group?
   a. name

   b. name

   c. name

   d. name

3. How much time did you spend on this assignment?

4. What percentage of the total did each person in your group contribute?

   a. yourself

   b. name

   c. name

   d. name

   e. name

LESSON PLAN - DAY 7

Title: "Introduction to Microcomputers"

OBJECTIVES

The students will develop an awareness of the concepts behind the microcomputer, computer operation and computer possibilities in the drafting/graphic arts laboratory.

Upon the completion of the lesson the student will be able to:

1. Identify a purpose of the microcomputer in the drafting/graphic arts laboratory.
2. Identify and define the three principles in computer operation.
3. Identify and define two forms of computer memory.
4. List and explain five safe procedures in handling and operating a computer disk drive unit and floppy disk.
5. Identify five individual units of computer hardware and their function.
6. Correctly differentiate between software and hardware.
7. Properly demonstrate how to load a floppy disk into a disk drive unit.
8. Locate and correctly turn power switch "on" and "off" on the microcomputer hardware.
9. Demonstrate a competent level of proficiency in operation of the computer graphic program.
10. Identify and correctly use the vocabulary terms.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

Microcomputer: monitor, keyboard, two disk drives, processor, printer, Koala Pad Touch Tablet and Stylus.
Software: Koala painter program, storage disk (initialized), Koala painter owner's manual, chalkboard.
Hints: Versions of Koalapad Touch Tablet are made for the Commodore 64 and Apple II computers. The Koalapad Program is recommended, but there are many software applications that may be used with a minor investment in hardware. The Koalapad was chosen because of its user friendly approach, cost and potential possibilities.

HANDOUTS AND WORKSHEETS

none

INTRODUCTION

Microcomputers are destined to be ranked along side automobiles and television sets as among the most significant invention of the twentieth century. What you may not realize is that within the next few years microcomputer's will be as common in our everyday lives as the telephone.

CONTENT OUTLINE

1. a. Discussion involving students on the usefulness of a microcomputer
   b. Bernard's Analogy I
   c. Bernard's Analogy II
   d. Discussion about the analogies
   e. Discussion of the three basic reasons for using a computer.

2. a. Lecture on the general principles of the microcomputer
   b. computer terms
   c. how the computer works internally
   d. analogy
   e. memory
   f. micropressor
   g. input/output
   h. hardware
   i. floppy disk/software
   j. floppy disk care

3. Demonstration of microcomputer

PROCEDURE

1a. USE INTRODUCTORY STATEMENT

Discussion over the usefulness of the computer:
- some tasks take people an excessively long time to do;
- some tasks are so repetitive that human resources are wasted;
- some tasks cannot be physically performed by people, or are too hazardous for people;
- computers can't create as people can
- they can only work under the guidance of their operators

1b. Bernard's Analogy I (Please read and expand upon as you present)

Your rich uncle in the northern portion of England died and bequeaths you his faithful servant, the butler. Soon your Uncle Bernard's butler shows up on your doorstep. What are you going to do with a butler? What will your friends think? Your simple lifestyle doesn't need to be frustrated with a butler tagging along. Especially one that doesn't even know anything about your lifestyle and for that matter the lifestyles of 99% of the American people. But the will is final and you must make do. There's no way out. Now this butler is friendly and nice to everyone and your friends even are starting to enjoy his presence but you're the one that must work with him. Everything must be explained to him. How to get somewhere - to driving on the right side of the road, even the American dollar, what's left of it. One thing about this butler though, he is fairly intelligent and is good company. Really it is not that bad having someone to answer the phone and get the mail and clean the house and all those other repetitive tasks. After some time with this butler, he is even paying bills, purchasing your clothes and even arranging social engagements. He is really not too bad, as a matterof fact, now you couldn't imagine ever not wanting a butler. A whole staff of butlers would be nice.

1c. Bernards Analogy II

Your rich uncle in the northern portion of England died and bequeaths you his faithful servant, the butler. This is the best thing to ever happen to you. Your very own personal servant. Everyone is going to be jealous! When the butler arrives on your doorstep he introduces himself. You can't understand a word he said. His British accent is so heavy and thick it's impossible to decipher this code called English. Not only that, but the butler can't even understand your American accent. This butler seems to be nice and polite but the communication gap is hard to handle. After some time it's beginning to seem as if you have to adjust to the butler and he is not adjusting to you. This is totally inappropriate. He should adjust to you, not vice versa. After a while you try to dismiss this butler, but the will states he is yours for life. This butler is totally destroying you life, you begin to wonder why you ever wanted a butler.

1d. These two analogies hopefully encompass most everyone's experiences with computers. The computer is a machine used to make your life easier, not harder. But approaching the computer is where people get fouled up. The computer is a tool for interaction. It will do as much and as well as you teach it or known as "Garbage in - Garbage out". Computerphobia is common. Once this is overcome, only by encounters with the computer you will have a steady friend for life. There is very little you can do to damage a computer just don't swim with one.

1e. Computers basically only do three functions.

Number crunching - basic arithmetic operations on numbers.
Benefits: speed, large quantities of numbers, short time, no errors.
Text Processing - working with letters, words and paragraphs.
Benefits: speed, rearranging, changing
Measurement and Control - Measure devices. Pressure temperature, etc. operation of machines
Benefits: speed, safety, no errors.

2a,b. For computers to be useful, you must give it something to do.
Anything that goes into the computer is call input.
Anything that comes out of the computer is called output.
The work that a computer does is called a process.
Data is a representation of something; the basic facts that can be processed.
Program is a list of instructions telling the microcomputer how to act on, or process, the data.

There are two kinds of input that a microcomputer can receive, program and data.

Every computer program is simply a sequence of numbers. Once a microcomputer has been properly programmed to do a task, it never again needs to be programmed for the task. The computer processes program and data with electrical signals. These signals are merely just a series of "on/off" switch called bits. A bit is an on/off switch in a computer. Eight of these switches are called a byte. One letter of the alphabet stored in the computer takes one byte memory. Some computers can hold thousands of bytes.

Approximately one thousand bytes are called a kilobyte thus "K". A computer with a capacity of 65,536 bytes is known as a computer with 64K of memory. An analogy that goes nicely with this might help to get the point across.

2c. You were the victim of a crime that took place in your home. The police have narrowed down the suspects to four people, all friends of yours. The police have good reason to believe that the criminal will return to the scene of the crime. The police have stationed an undercover police car near your home to insure apprehension of this friend that turned sour. There arises a need to signal the patient police in the undercover car. But how? The phone wouldn't work, a radio would put you in danger and to scream your head of is worse. The situation calls for a way to signal the police without the suspect to know what is happening. You come up with an idea of lights in different rooms of the house. But the police could only see in the kitchen and dining room from their location. But two lights and four suspects will work great. Each suspect is assigned a combination of lights either "on-on", "off-off", or "on-off", "off-on". The suspect arrives, you signal and they are arrested. The computer operates the same way. A computer has 256 keyboard functions. Eight "on-off" switches or bytes will handle any of 256 symbols. These bytes hold binary information. If a switch is "on" it will represent a "1". If a switch is "off" it will represent a "0". A byte might look like this "0111010".

2e. There are two types of memory, RAM and ROM. RAM or Random Access Memory is a temporary memory. If the power is disconnected in some way then the information is lost. It will not return. It really should be called RWM for Read/Write/ Memory, but its easier to say RAM instead of RWM.

The second memory is ROM or Read only Memory. ROM is non-volatile. When power is lost ROM still exists. ROM exists only for the use of the computer. It contains internal administrative programs such as languages and operating systems that the computer will understand. ROM can have its contents read but data cannot be entered onto it except for once, during the manufacture of it.

2f. The key for microcomputers is its internal system. The "chip" or integrated circuit" (closed path through which electricity can flow) (I.C.) is a miniature electronic circuit, enclosed in a small package. Many of the IC's (integrated circuit) make up a microprocessor. So a micropressor is basically an I.C. A very large one but still an integrated circuit. A Micropressor cannot do anything on its own: it must be connected to other components. Just like an amplifier of stereo needs speakers and a tuner. The computer needs a memory, power supply and devices that enter data in and out of the processor and memory.

2g. Devices that get data into and out of the processor are called input/output devices. Examples are keyboard, printer, monitor, joystick, graphics tablet, to name a few. What all these are considered is hardware.

2h. Simply, hardware is the nuts and bolts of the computer. On the other hand there is software. Software is a generic term given to computer programs. They are referred to as software because programs are stored in memory that cannot be seen or felt but are transferred by electrical signals in a floppy disk or cassette tape.

2i. A floppy disk is a devise that store large amounts of data in a form that allows fast access to it. Floppy disks are so called because they consist of a flexible plastic disk that is coated with oxide. Information stored on a disk can be retrieved with electronic impulses. Floppy disks are the most common storage medium for microcomputers.

2j. Treat floppy disks with care. Here are some rules to live by:

- Always keep floppies in their wallets. They are antistatic, as well as protecting them from dust.
- Never bend, fold. or otherwise manipulate the disk.
- Never touch any of the exposed areas of the disk.
- Don't leave disk too near television, telephones, monitors, power cables or any other source of magnetism. Magnetism will erase the disk.
- Never force the disk into its drive or into the wallet.
- Don't leave disks lying in the sun or near heaters or sources of cold air.
- Keep food, drink, and smoke away from disks.

3. Demonstration of the microcomputer. Using the Koalapad program. (As stated earlier, there are many possible programs to use for computer graphics. Please consult with your owners manual for proper operation.) (There's a program that may be used to explain this.)

Turn all hardware being used "on".
Insert Koalapainter diskette into the disk drive.
Enter on the keyboard - LOAD KPAINT,8 (return)
There will be a brief pause of 60 seconds or so while the program is being LOADED.
Do not touch any keys.
(print) RUN (return)
Demonstrate the DRAW, BRUSH WIDTH, FILL CIRCLE, BOX and Memory Systems.
To record the comprehensive you may use a pro-writer printer or you may photograph the screen with a polaroid camera. The best possible option is to save the comprehensive on a disk in the memory system.

SUMMARY AND FUTURE TOPICS

Computer Applications

ASSIGNMENTS

Continued work on Assignment #3.

REVIEW QUESTIONS & VOCABULARY

Vocabulary:

1. Input
2. Output
3. Process
4. Data
5. Program

6. Bits
7. Byte
8. Kilobyte
9. RAM
10. ROM
11. Integrated circuit
12. Microprocessor
13. Keyboard
14. Printer
15. Monitor
16. Hardware
17. Software
18. Floppy disk
19. Disk drive unit
20. Program

REFERENCES

LESSON PLAN - DAY 8

Title: "Computer Applications"

OBJECTIVE

Stimulate the students imagination and awareness of the development of a design involved with a microcomputer.

Upon completion of this lesson the student will have:
1. Listened to video tape introduction.
2. Viewed the video tape "Computer Graphics".
3. Interacted in a discussion about the video tape "Computer Graphics".
4. Received Assignment #4.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

1. Television set
2. Video Cassette Recorder (½ inch tape)
3. Computer Graphics video tape
4. Chalkboard

HANDOUTS AND WORKSHEETS

Assignment #4
Evaluation Criteria Sheet

INTRODUCTION

Identify key points of video tape during previewing and share with the students.

CONTENT OUTLINE AND PROCEDURES

Procedure:
1. Introduction to the video tape -
   "Computer Graphics" video tape traces the early history of graphic programs involving the computer. Highlights of major computer graphics breakthroughs are shown. 5 minutes.
2. Play video tape "Computer Graphics" to students.
3. Discuss applications that were presented in the video tape that are available for possible student use in their assignments.
4. Assign students to develop 4- 6 thumbnail sketches to be due the next day. (See assignment 4.)

SUMMARY AND FUTURE TOPICS

None

ASSIGNMENT

Assignment Objective: Student will use the principles of design to generate thumbnail sketches and rough drafts. The microcomputer will be used to generate the comprehensive.

Student Objectives: Upon completion of this assignment students will have:

- generated 4-6 thumbnail sketches
- critiqued thumbnail sketches
- develop thumbnails in proper form
- identify a thumbnail sketch
- generate a rough draft
- learn to operate the microcomputer in the graphics package
- develop a comprehensive using the microcomputer

Instructor options:

1. The design may be a logo for a fictitious company or an international language traffic sign. Other options may be billboards, flags, buttons, or greeting cards.
2. The design should be kept fairly simple to allow effective time on the computer.
3. A program has been written on the operation of the Koalapad Painter program. You may wish to use this for students experiencing difficulties.
4. Students may possibly work in groups to develop a logo for an instructor if class size is detrimental for effective use of microcomputer.
5. This assignment (4) is also meant to run parallel to Assignment 3.
6. Student should try to limit their classroom computer time to ten minutes.
7. There are a few options in saving the comprehensive generated on the computer. Save the drawing on a separate disk in the disk drive unit, take a Polaroid print of the screen, or view the drawing as the student finishes it. This way presents a problem for some labs. Another option is to use a pro-writer printer and dump the screen on the printer.

Name ____________________

Period____________________

ASSIGNMENT SHEET - DESIGNS

Rationale: The purpose of this assignment is to have you apply design theory to actual practice. It will also include image generation using a computer.

Objectives: Stimulate the students imagination and awareness of the development of a design using microcomputer.

Assignment: Using the design process as we discussed in class you will produce on paper thumbnail and rough sketches. You will produce a comprehensive on a computer.

Assignment Requirements:

1. Contract with someone or some organization to produce a logo for them.
2. Determine their needs.
3. Thumbnail sketches
    a. 4-6 sketches showing sequential development (central theme)
    b. In pencil on neat white 8½ x 11 paper
    c. Chosen thumbnail must be initialed by the instructor before proceeding.
    d. Use of correct lines and symbols to denote design elements.
4. Rough Sketch
    a. Actual size
    b. Pencil on neat white 8½ x 11 paper
    c. Drawn with instruments
    d. Type & illustrations represented actual size and location on layout.
    e. Approved and initialed by client
    f. Approved and initialed by instructor.
5. Comprehensive
    a. Generated on computer.
    b. Actual size.
    c. In color (one ink, one paper)
    d. Type and illustrations generated on the computer.

Design Limitations:

a. design should be original
b. design in one color only
c. no continuous tone photography (no snapshots)
d. simple detail must be appropriate for reproduction by a number of methods
e. design must be in good taste (The definition of good taste is entirely at the instructors whim.)

Name ______________________

Period______________________

EVALUATION SHEET FOR DESIGN PROJECT

	0	1	2	3	4	5
1. Has the student identified the client for the project?	0	1	2	3	4	5
2. Have the clients needs been identified?	0	1	2	3	4	5
3. Do the thumbnails show sequential development?	0	1	2	3	4	5
4. Do the thumbnails otherwise meet the assignment requirements?	0	1	2	3	4	5
5. Does the rough sketch meet the assignment requirements?	0	1	2	3	4	5
6. Is the comprehensive generated on the computer?	0	1	2	3	4	5
7. Is the comprehensive filed correctly?	0	1	2	3	4	5
8. Does the comprehensive fit within the design limitations?	0	1	2	3	4	5
9. Did the student correctly identify the way they applied the design principles?	0	1	2	3	4	5
10. Does all the submitted work show thought and care on the part of the student?	0	1	2	3	4	5

Point Total ____________

Additional Comments:

LESSON PLAN - DAY 9

Title: "Lab Activities"

OBJECTIVES

Students will be involved with peer analysis of thumbnail drawings and use class time for assignments 3 and 4.

Upon completion of this lesson the student will:

1. Interact in a positive manner in critiquing thumbnail sketches.
2. Explain thumbnail sketches to members of their group.
3. Determine which thumbnail has the most potential to develop into an effective design.
4. Use class time effectively and wisely.
5. Develop thumbnail sketches into rough drafts.
6. Use critique forms provided in early assignment 1.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

Same as Day 7

HANDOUTS & WORKSHEETS

Assignment 1 critique sheets

INTRODUCTION

You will be given an opportunity to evaluate your classmates.

CONTENT OUTLINE AND PROCEDURES

1. Critique thumbnail activity.
2. Explanation of rough draft.
3. Class lab time for assignments 3 and 4.

1. Divide students into groups of 3 to 4 for critique activity. Explain to students that they will present each of their thumbnails to the group for group critique. 10-12 minutes.
2. Allow classroom time to work on the development of thumbnail sketch into rough draft due the next day.

SUMMARY AND FUTURE TOPICS

Remember the Quiz tomorrow

ASSIGNMENTS

None

REVIEW QUESTIONS AND VOCABULARY

None

REFERENCES

LESSON PLAN - DAY 10

Title: "Lab Activities"

OBJECTIVES

The student will develop a rough layout from their thumbnail sketches.

TOOLS, EQUIPMENT, MACHINES, AUDIO VISUALS

Microcomputer and software
Paper
Pencil, eraser
May need library

HANDOUTS AND WORKSHEETS

Quiz #2

INTRODUCTION

You will need to take your thumbnail sketches and develop full page rough layout.

CONTENT OUTLINE AND PROCEDURES

I. Individual or group help given by instructor.

SUMMARY AND FUTURE TOPICS

None

ASSIGNMENT

Tomorrow will have more time in class to work on history and logo assignment.

REVIEW QUESTIONS AND VOCABULARY

None

REFERENCES

See reference list from history lesson

MICROCOMPUTER QUIZ #2

1. Name three basic functions a computer uses.
   input-output - process

2. What is a program? A list of instructions telling the computer what to do.

3. Eight bits are called (a/an)___________. byte

4. Name and give a description of two types of computer memory.
   RAM - Random Access Memory is only temporary, it is lost when power is off.
   ROM - Read Only Memory contains internal commands and is non volatile.

5. List 5 safety practices in handling a floppy disk.
   Keep floppies in their wallets.
   Don't bend, fold or manipulate.
   Never touch exposed areas of the disk.
   Never let disk come in contact with magnetism.
   Control climate areas around disks.
   No food or drink or smoke around disks.

6. What is hardware and how is it alike or different from software?
   Hardware is the nuts and bolts of a computer and software programs
   are used in the memory systems.

HISTORY QUIZ II

1. Which statements best describes Johann Gutenberg?

   a. Born in Bavaria, Germany in 1789, this man wrote a play entitled "Die Matedchenkenner". The high cost of advertising for this play caused him to experiment with copperplate and limestone engraving. These experiments led to the observation that oil and water do not mix. He called this method of stone printing "lithography".
   b. This man is generally considered to be the father of printing in the Western world. A master craftsman in metalworking he designed and cast the first individual-letter relief type. His most notable work was a forty-two-line Bible.
   c. Born in the city of Mainz, Germany in 1397, this man desinged the first truly automatic typesetting machine. His invention, called one of the ten greatest in the history of the human race, won him the title of "father of printing in the Western world."

2. A concept (or group of concepts) that extends or amplifies the ability to meet a human need. Ideas or rules created and controlled by humans to meet human needs. What word best fits these descriptions?

   a. Technique
   b. Applied science
   c. Invention
   d. Technology
   e. Industry

3. What 5 channels do human beings use to send and receive messages?

   a. Thought,language, reading, sensitivity, odor
   b. Sight, hearing, smell, hunger, movement
   c. Contact, appetite, temperament, scent, seeing
   d. Posters, radio, television, magazines, papers
   e. Sight, sound, smell, taste, touch

4. Visual communication is said to have two purposes. One is to send messages to our contemporaries.
   What is the meaning of contemporary?

   a. Those not yet born
   b. Those who came before us
   c. Those who will follow us
   d. Those who exist now
   e. Only those who can see us

5. Which of these are not temporary visual messages?

   a. Wave, smile, nod
   b. Frown, wink,tears
   c. Letter, photo, sketch
   d. Motion, or lack of motion

6. Which of these is not a medium of temporary visual messages?

   a. Television
   b. Stop lights
   c. Signal flags
   d. Blinking railroad signals
   e. Shaking a finger

7. Which of these is not a medium of permanent visual messages?

   a. Dance and theater
   b. Videodiscs and videotape
   c. Printing and books
   d. Movies and photographs
   e. Microfilm and microfiche

8. What is mass media?

   a. Communication that appeals to more than one of the senses
   b. The normal way most humans send messages
   c. The bulk of all forms of visual entertainment designed to reach a large audience
   d. Nongraphic methods of communication

9. What do we call drawings that carry meaning by attempting to replicate real objects?

   a. Ideographs
   b. Phonetics
   c. Graffiti
   d. Pictographs

10. As early as 35,000 BC, people were drawing messages on cave walls. We call these drawings pictographs.
    Which one of these statements is false?

    a. Pictographs replicate real objects
    b. Pictographs have a one-to-one relationship with reality
    c. Pictographs symbolize abstract ideas, such as love or hate
    d. Pictographs cannot illustrate complicated ideas

11. This system was perhaps the beginning of most written languages. Picture symbols came to represent a sound; whenever readers saw the symbol, they could duplicate the sound. When symbols were placed together, words could be formed and repeated.
    What society is given credit for this change?

    a. Phoenician
    b. Greek
    c. Roman
    d. Egyptian
    e. Chinese

12. All of these statements describe the Phoenician symbol system except:

    a. The system contained nineteen symbols
    b. With this system a picture symbol came to represent a sound
    c. With this system people could form verbal symbols by combining consonants and vowels
    d. Because the symbols were few and contained no vowels, the system was of little use in recording everyday speech
    e. The system is the basis for most modern written languages

13. According to the dictionary, "alphabet" is the series of letters used in writing a language. The word is formed by joining the names of two symbols "alpha" and "beta".
    From what language did these letters originate?

    a. Algerian
    b. Phoenician
    c. Greek
    d. Roman
    e. Latin

14. By 403 BC, the Greeks had officially adopted the Phoenician symbol system. With minor symbol and name changes, the system was workable. It was not until another major addition was made to the new alphabet that speech could be successfully recorded.
    What was that addition?

    a. Vowels were added
    b. The letters F, Q, W, and J were added
    c. Punctuation marks were added
    d. Lowercase letters were added
    e. The letter U was added

15. The Roman empire borrowed the alphabet from the Greeks and went on to refine it to meet their needs.
    How many letters were in the Latin alphabet?

    a. 19
    b. 23
    c. 26
    d. 10,000
    e. 20

16. How many letters form our contemporary Latin alphabet?

    a. 26
    b. 28
    c. 40
    d. 23

17. By the mid 1850s handwritten letters and hand-set copy declined in popularity. Printers feared their work would be taken over by a new implement.
What was that implement?

    a. Camera
    b. Computer
    c. Typewritter
    d. Duplicator
    e. Radio

18. The first commercial halftone illustration was a scene in Shannytown, New York. It appeared in the New York Daily Graphic Newspaper on March 4, 1880. It was considered a bold and new experiment and an improvement in printing technology. Before halftones, the only way to add illustrations to a printed piece was to :

    a. Photograph a continuous-tone image
    b. Include a snapshot with varying shades of gray
    c. Break the many visual tones of a photograph or tintype into small dots
    d. Make use of detailed line drawings provided by an artist

19. Full-color illustrations are a relatively new technology for the printing industry. It was Fredrick E. Ives, a journeyman printer, who researched and developed the tri-color process.
His first color illustration was printed in:

    a. 1780
    b. 1893
    c. 1932
    d. 1950

20. Who is recognized as the inventor of lithography?

    a. Frederick Ives
    b. Alois Senefelder
    c. Ottmar Mergenthaler
    d. Johannes Gutenberg
    e. Frederick Konig

21. The first slab of lithographic stone was quarried in Kelhein, Germany.
It was:

    a. marble
    b. pumice
    c. granite
    d. limestone
    e. agate

22. The basis for all contemporary lithographic printing is the concept of:

    a. a rough surface retaining moisture
    b. acid etching the surface
    c. grease adhering to an exposed surface
    d. Pressing paper on an inked surface
    e. moisture and ink repelling each other

23. "Lithography" is based on two Greek words - "Lithos and "graphein". "lithos" means stone. What is the meaning of "graphein"?

    a. to carve
    b. to write
    c. to print
    d. to etch
    e. to transfer

24. Lithography developed a reputation as a fine arts process in America through the prints of the .... Company.

    a. Audubon Society
    b. Hallmark
    c. Currier and Ives
    d. American Heritage
    e. Carriage House

25. What is the name of the process in which a slab of stone is cleaned and ground to a perfectly flat surface?

    a. grinding
    b. grating
    c. graining
    d. grading
    e. leveling

26. The first high-speed printing press was designed around 1450 by Johann Gutenberg (the term "high-speed" being relative to printing methods that preceded this invention). Gutenberg experimented with several different designs but decided that the one resembling a .... worked most efficiently.

    a. grinding mill
    b. spinning wheel
    c. metal forge
    d. wine press
    e. coffee grinder

27. It took over three years to print 200 copies of Gutenberg's famous 42 line:

    a. atlas
    b. almanac
    c. hymnal
    d. thesis
    e. Bible

28. It is generally accepted that the invention of .... has made the craft of printing "the" most powerful influence upon the social, scientific, and political history of humanity.

    a. the printing press
    b. paper
    c. ink
    d. relief type
    e. the alphabet

29. Gutenberg's "high-speed" press could operate at the fantastic rate of 20 copies every:

    a. minute
    b. hour
    c. twelve-hours
    d. day

30. Sometime between 1798 and 1800, Alois Senefelder designed the first:

    a. Copperplace engraving
    b. Flat bed cylinder press
    c. Automatic dampening system
    d. Lithographic press
    e. Ink-covered leather roller

31. Sanefelder's press was considered a marvel of its time. In an average .... work day, two craftsmen could produce 50 acceptable copies.

    a. 8-hour
    b. 12-hour
    c. 14-hour
    d. 24-hour

32. Senefelder's basic press design was not changed until the "offset" press was introduced in ....

    a. 1800
    b. 1810
    c. 1850
    d. 1866
    e. 1907

33. Around 175 AD, the Chinese began making stone cuttings. These stones carried the writings of important scholars and were kept in centers of learning where students could make copies.
These copies were called:

    a. block prints
    b. tracings
    c. rubbings
    d. transfers

34. The earliest relief composition can be traced back to:

    a. ceramic stamps
    b. carved wood blocks
    c. rubber stamps
    d. stone carvings
    e. potato prints

35. The words of Confucius were reproduced on paper from a raised surface that was carved from a ....slab.

    a. Clay
    b. Resin
    c. Wooden
    d. Wax

36. Building upon the ideas of block printing Pi Sheng invented:

    a. bronze type
    b. screen printing
    c. clay matrices
    d. movable type
    e. an ink brayer

37. On July 3, 1886, the first truly automatic typesetting machine was demonstrated in the composing room of the New York Tribune. The device was designed by Ottmar Mergenthaler and has been called one of the ten greatest inventions in the history of the human race. This machine was the:

    a. Intertype
    b. Monotype
    c. Foundrytype
    d. Linotype
    e. Ludlow

38. The machine designed around 1888, which can cast type from hand-set matrices in sizes from 8 to 144 points, is a:

    a. Paige
    b. Ludlow
    c. Mergenthaler
    d. Linotype
    e. Monotype

39. An early paper-like substance invented by the Egyptians was called:

    a. Papyrus
    b. Pith
    c. Eucalyptus
    d. "Laid" paper

40. The first truly "modern" paper was invented by:

   a. The Didot family
   b. Frenchman, Nicholas Luis Robert
   c. John Gamble
   d. Ts'si Lun
   e. The brothers Fourdrinier

41. Ottmar Mergenthaler is famous for inventing:

   a. the offset press
   b. the linotype machine
   c. continuous photography
   d. photo silkscreen printing
   e. none of the above

42. Software is:

   a. a term synonymous with hardware
   b. only important to those installations that do not have their own program
   c. used to find electronic circuits which are termed "soft" because they fail on occasion
   d. a series of programs which aid in the running of the computer system

43. The input units on a computer system

   a. present data to the processor unit of the computer system
   b. are used only when there is not sufficient main computer storage
   c. accept data from the computer system for use by human beings
   d. process the data using the electronic circuitry of the computer system

44. Output units are used to:

   a. store data after it has been processed and before it is made available to people for use.
   b. display print, or otherwise make available to people the results of the processing of the data.
   c. make the data available for processing
   d. actually process data prior to making it available for use.

45. A processor unit:

   a. stores the data to be processed and contains the electronic circuitry necessary to carry out the processing of the stored data
   b. displays the results of the processed data
   c. is not necessary for those computer systems which have input units and output units
   d. consists of main computer storage and a CRT Terminal

46. The modern Roto Gravure process was developed by Karl (Klic) Klitsch in the later 1870's. The process he adapted was called:

a. lithography
b. letterpress printing
c. intaglio printing
d. relief printing
e. none of the above

LESSON PLAN - DAY 11

Title: "Lab Activities"

OBJECTIVES

The student will work on history assignment as needed.
The student will work on rough layout assignment as needed.

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

Microcomputer & software
Paper
Pencil
Eraser
May need library

HANDOUTS AND WORKSHEETS

None

INTRODUCTION

Some students may need to go to the library for reference work.
Other students will be working on microcomputer or on history assignment.

CONTENT OUTLINE AND PROCEDURES

1. Return and briefly go over the Quiz.
2. Individual or group help given by instructor.

SUMMARY AND FUTURE TOPICS

Student or group history reports and presentation should be nearly completed for the following day.

ASSIGNMENTS

Assignment #3 on history will be due the following day.

REVIEW QUESTIONS AND VOCABULARY

None

REFERENCES

See references for microcomputer lesson

LESSON PLAN - DAY 12

Title: "Student Reports"

OBJECTIVES

See previous objectives for this assignment (Day 6).

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

The following equipment should be on hand for use by the students.

1. Overhead projector
2. Slide projector
3. Chalk board w/colored chalk
4. Clock or watch w/second hand

HANDOUTS AND WORKSHEETS

Evaluation sheets for oral reports

INTRODUCTION

Today is one of two days that have been set aside to allow you to practice your oral communication skills. These skills will be useful to you in most job situations and in any organizations in which you choose to belong.

Remember, each of you will evaluate each presentation using the sheets provided when the assignment was made. I'm certain that you will evaluate your peers fairly and objectively.

PROCEDURE OUTLINE

I. Introduction.

   A. Appoint student(s) as official time keeper(s). Provide with watch or clock if necessary.

   B. Review evaluation procedure.

   C. Present your introduction.

II. Reports.

   A. Collect outlines for reports.

   B. Have students present oral reports in chronological order.

   C. After each report is given collect the written reports.

   D. Collect evaluation sheets after each report.

III. Summary - 3-5 minutes before class dismissal.

A. Summarize the day's presentations.
Relate to other major historical developments
that paralell those in the reports.

B. Lead in or set up for tomorrow's reports. (end
with a question to be answered - tomorrow what
question?)
Did these inventions or discoveries, and the people
involved shape history, or did history shape them?

LESSON PLAN - DAY 13

Title: "Student Reports - continued"

OBJECTIVES

See Day 6

TOOLS, MACHINES, EQUIPMENT, AUDIO VISUALS

1. Overhead projector
2. Slide projector
3. Chalk board w/colored chalk
4. Clock or watch w/second hand

HANDOUTS AND WORKSHEETS

Evaluation sheets for oral reports

INTRODUCTION

Discuss the students thoughts and yesterday's ending question.

CONTENT OUTLINE

I. Introduction

II. Student Reports

PROCEDURE OUTLINE

I. Introduction

    A. Discuss the question
    B. Introduce first speaker

II. Student reports

    A. Collect outlines for reports
    B. Students give reports
    C. Collect the written reports
    D. Collect the evaluation sheets

III. Summarize Reports - Think about what the future may bring.

IV. STUDENT LAB

LESSON PLAN - DAY 14

Title: "Assignment Critique and Test Review"

OBJECTIVES

Students will critique assignment 4 and review.

Upon completion of this lesson the student will have or be able to:
1. Actively participate in a class critique of assignment 4.
2. Present his or her comprehensive design to the class.
3. Interact in a discussion over unit.

TOOLS, MACHINES, EQUIPMENT AUDIO VISUALS

Microcomputer package
Large color monitor or television set
(Opaque projector optional)

HANDOUTS AND WORKSHEETS

Sheets for design project
Peer Evaluation

INTRODUCTION

None

CONTENT OUTLINE AND PROCEDURE

1. Critique student comprehensives.
2. Summary discussion over unit.

Explain to students what they are to be critiquing -- design principles. Space, shape, form, color, proportion. Unity line, balance - informal, formal, rhythm.

View the comprehensive designs on the color monitor. If the comprehensives are on film or print you may use an opaque projector to view them.

Discuss with students the major topics that were presented in this unit. Design, History, Microcomputer.

ASSIGNMENT

The Module

REFERENCES

These references were all printed since 1982. Obtain current references from your library.

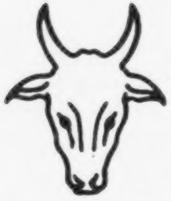
"Discovering Computers", Frank, Mark
"Beginners Guide to Home Computers", Grosswirth, Marvin
"Bits'n Bytes about Computing", Heller, Rachelle S.
"Easy to Understand Guide to Computers", Consumer Guide Report

TIME LINE

35000 BC	CAVE PAINTING.
4000 BC	GODEA EARLIEST TECHNICAL DRAWING.
2500 BC	ALPHABETS(EGYPTIAN).
980 BC	TEMPLE AMON KARNAK EGYPT 200 YEARS TO COMPLETE.
900 BC	PHOENICIANS — PHONETIC ALPHABET.
105 AD	CHINA — TS'AI LUN PAPER.
114	ROMAN ALPHABET.
175	CHINA — RUBBINGS FROM STONE CARVINGS.
770	CHINA — RELIEF PRINTING — DIAMOND SUTRA.
960-1280	CHINA — JAPAN — STENCIL PRINTING.
1100	CHINA — MOVABLE TYPE(CAST EARTHENWARE).
1300	ITALIAN RENAISSANCE — INTAGLIO PRINTING.
1400	ALBERTI, BRUNE CLESCHI — THEORY OF PROJECTIONS OF OBJECTS VEIWS.
1452	GUTENBURG — MOVABLE METAL TYPE.

1700'S	FABER(GERMANY) GRAPHITE PENCIL.
1737	PICA & POINT SYSTEM — SIMON — PIERRE FOURNIER.
1796	ALOIS SENEFELDER — LITHOGRAPHIC PRINTING.
1798	PAPER MAKING MACHINE — NICOLAS LOUIS ROBERT.
1800	FIRST LITHO PRESS — SENEFELDER.
1802	SIR HUMPHRY DAVY & THOMAS WEDGEWOOD — PHOTOGRAPHY.
1811	FEREDRICK KONNING — POWER ROTARY CYLINDER PRESS.
1839	DAGUERREOTYPY — LOUIS JACQUES MEND'E DAGUERRE .
1840	PHOTOGRAPHIC NEGATIVES — WILLIAM TALBOT; TELEGRAPH SFB. MORSE.
1847	ROTARY STEREO TYPE PRESS — ROBERT M. HOE.
1852	HALFTONE SCREEN HENRY TALBOT.
1866	POWERED LITHO PRESS.
1875	GRAVURE PRINTING — KARL JUTSCH MERGENTHALER.
1876	TELEPHONE — ALEXANDER G. BELL.

1878	MANUAL TYPEWRITER.
1880	FLEXIBLE BASE FILM — GEORGE EASTMAN.
1885	GLASS X LINE HALFTONE SCREEN — FREDRICK IVES.
1890	ROTO GRAVURE — KARL(KLI'C) KELITSCH(AUSTRIA).
1897	MARCONI — RADIO.
1903-07	OFFSET PRESS — IRA RUBLE (AMERICAN).
1907	SAMUAL SIMON — TRUE SCREEN PRINTING(ENGLAND).
1910-20	PHOTO — OFFSET LITHOGRAPHY.
1934	ELECTRIC TYPEWRITER.
1950'S	PHOTO TYPESETTING.
1958	DEC 18 - SCORE-FIRST COMMUNICATIONS SATELLITE.
1960'S	SATELLITE TRANSMISSIONS BECAME PREVALENT — ECHO, TELSTAR, INTELSTAT.
1969	JULY 16-24 -APOLLO II LANDED ON THE MOON.
1980	DIGITAL TYPESETTING & PAGINATION.



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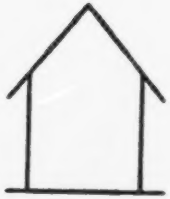
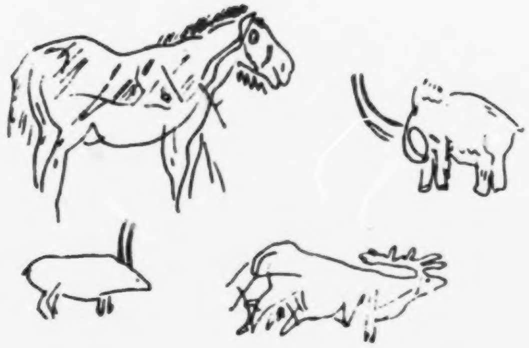
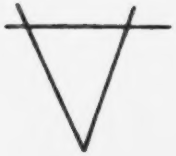


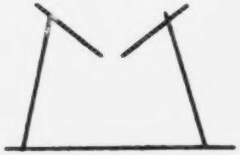
HOUSE



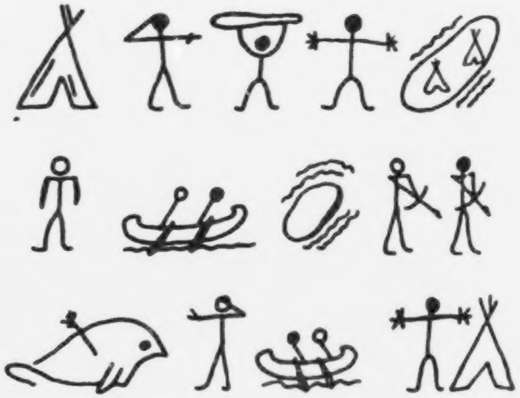
PICTOGRAPH



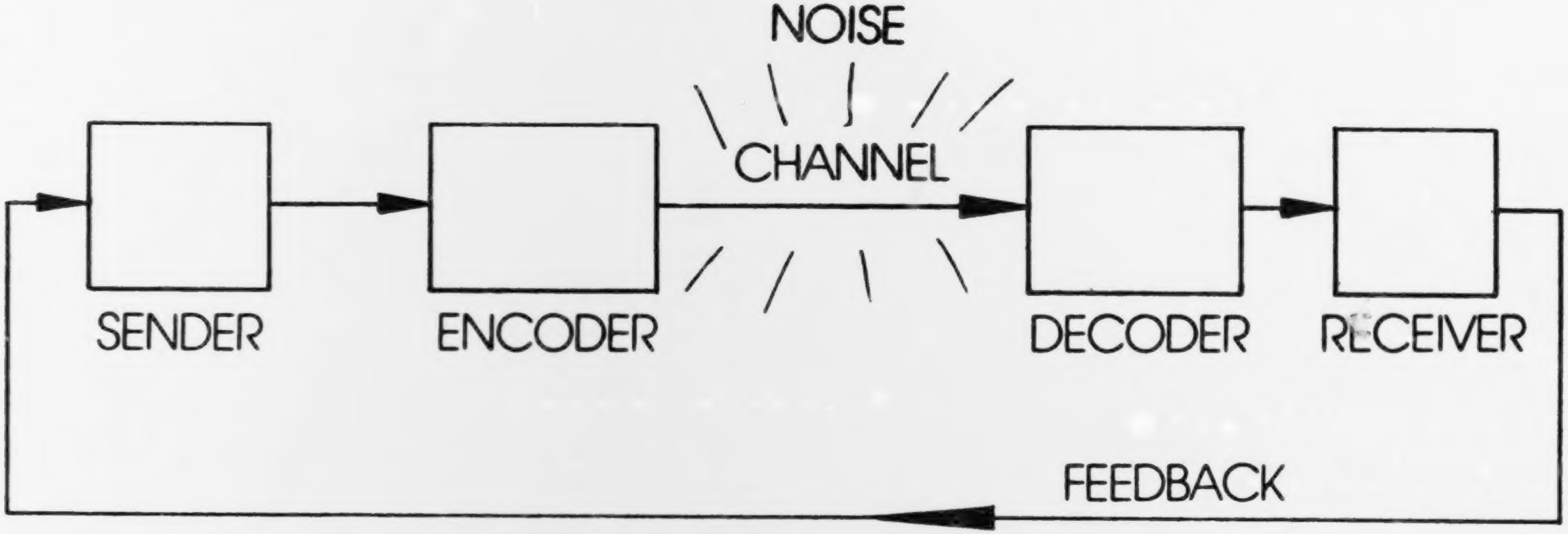
FOOD



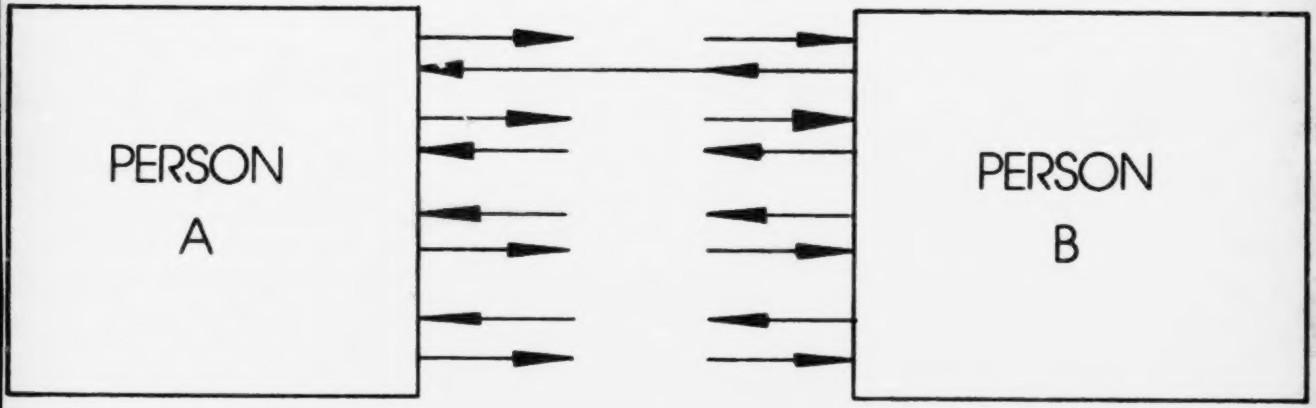
SHELTER



IDEAGRAPH



COMMUNICATION MODEL



⇄ **COMMUNICATION CHANNEL (SIGHT, SOUND, SMELL, ETC.)**

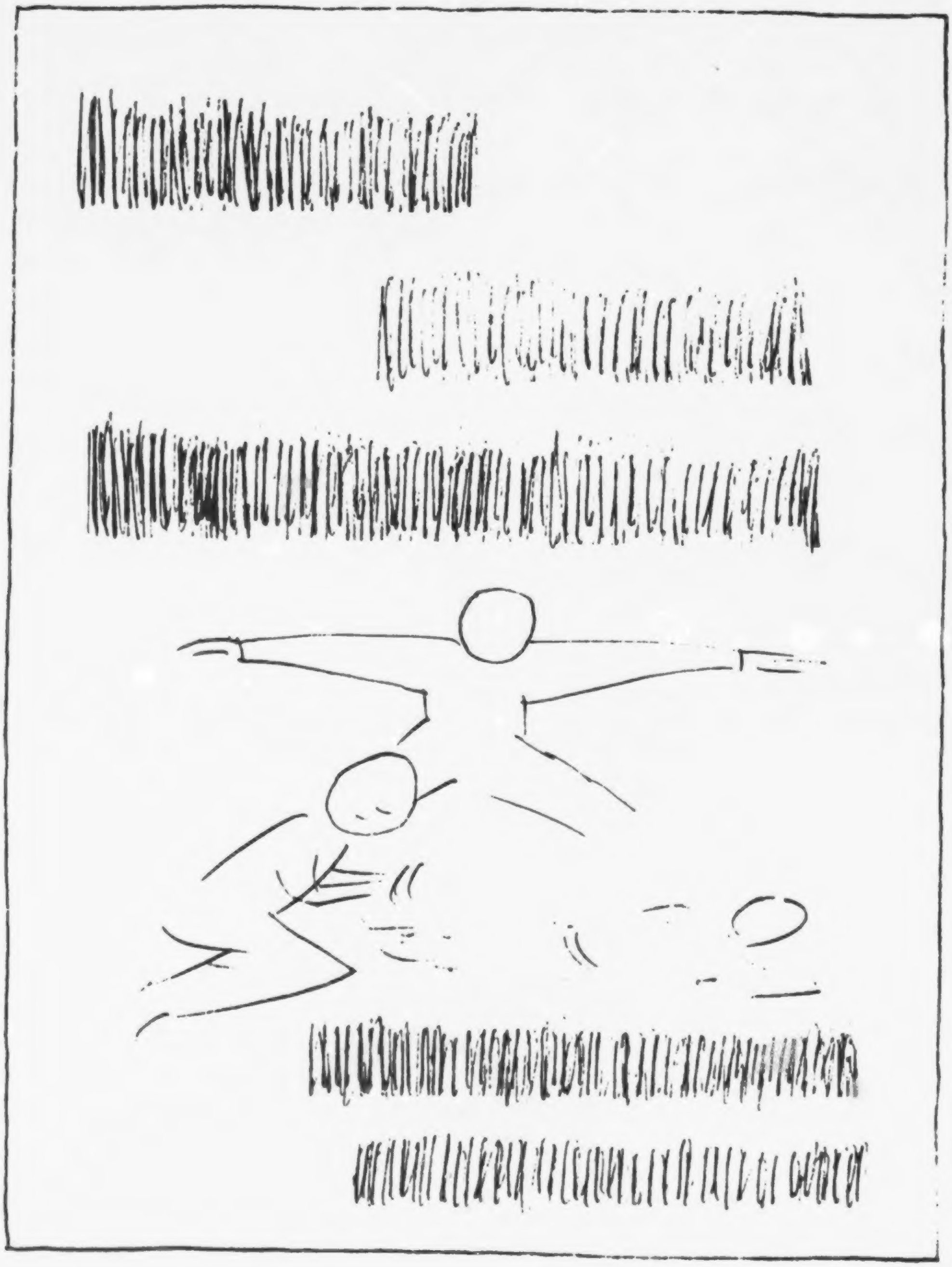
ALPHABETS

1	𐤀	𐤁	𐤂	PHOENICIAN
2	Α	Β	Γ	GREEK
3	A	B	C	ROMAN
4	A	B	C	MODERN

STEPS REQUIRED FOR THE PRODUCTION OF GRAPHIC COMMUNICATIONS ITEMS

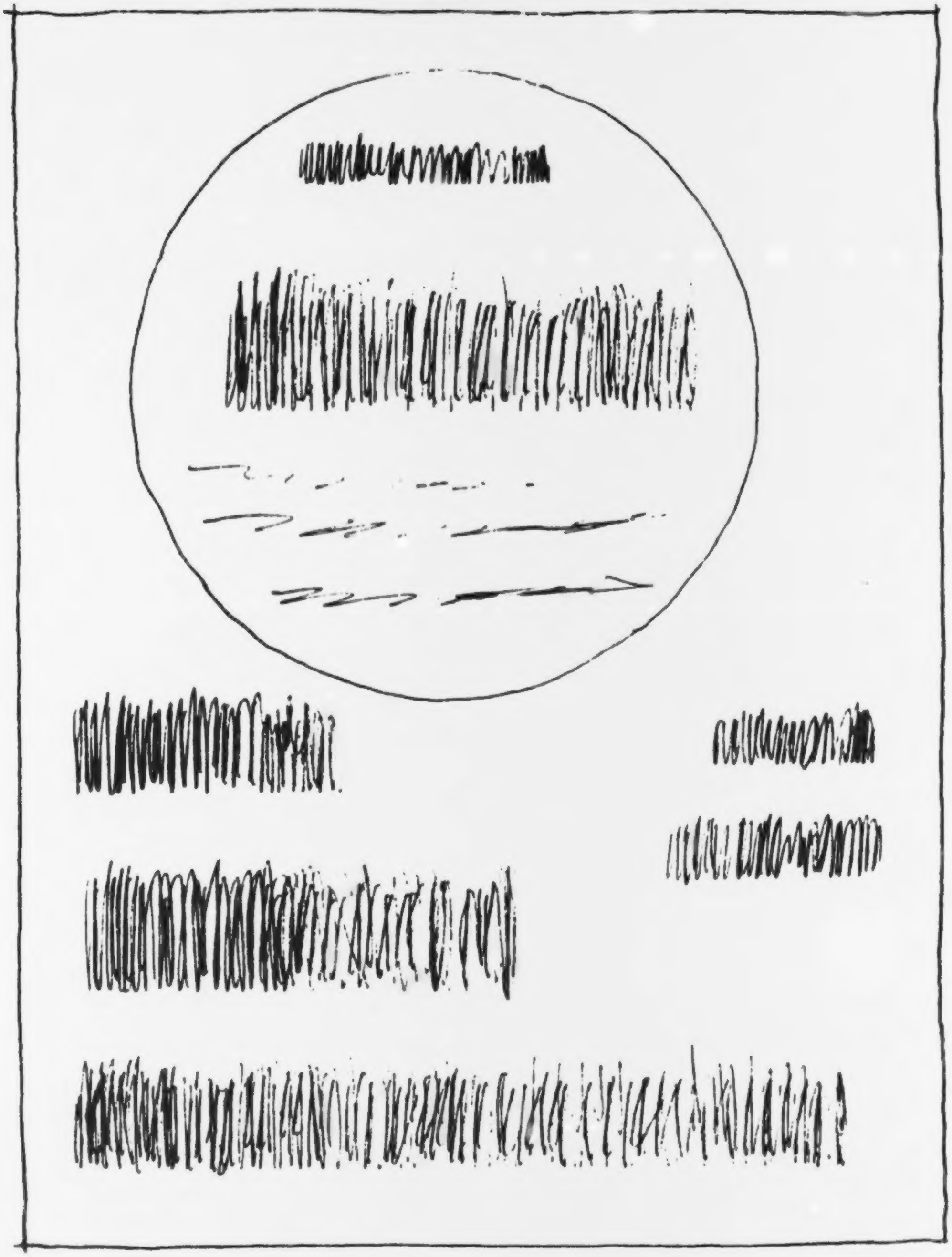
1. IMAGE DESIGN
2. IMAGE GENERATION
3. IMAGE CONVERSION
4. IMAGE CARRIER PREPARATION
5. IMAGE TRANSFER
6. FINISHING

D



C

B



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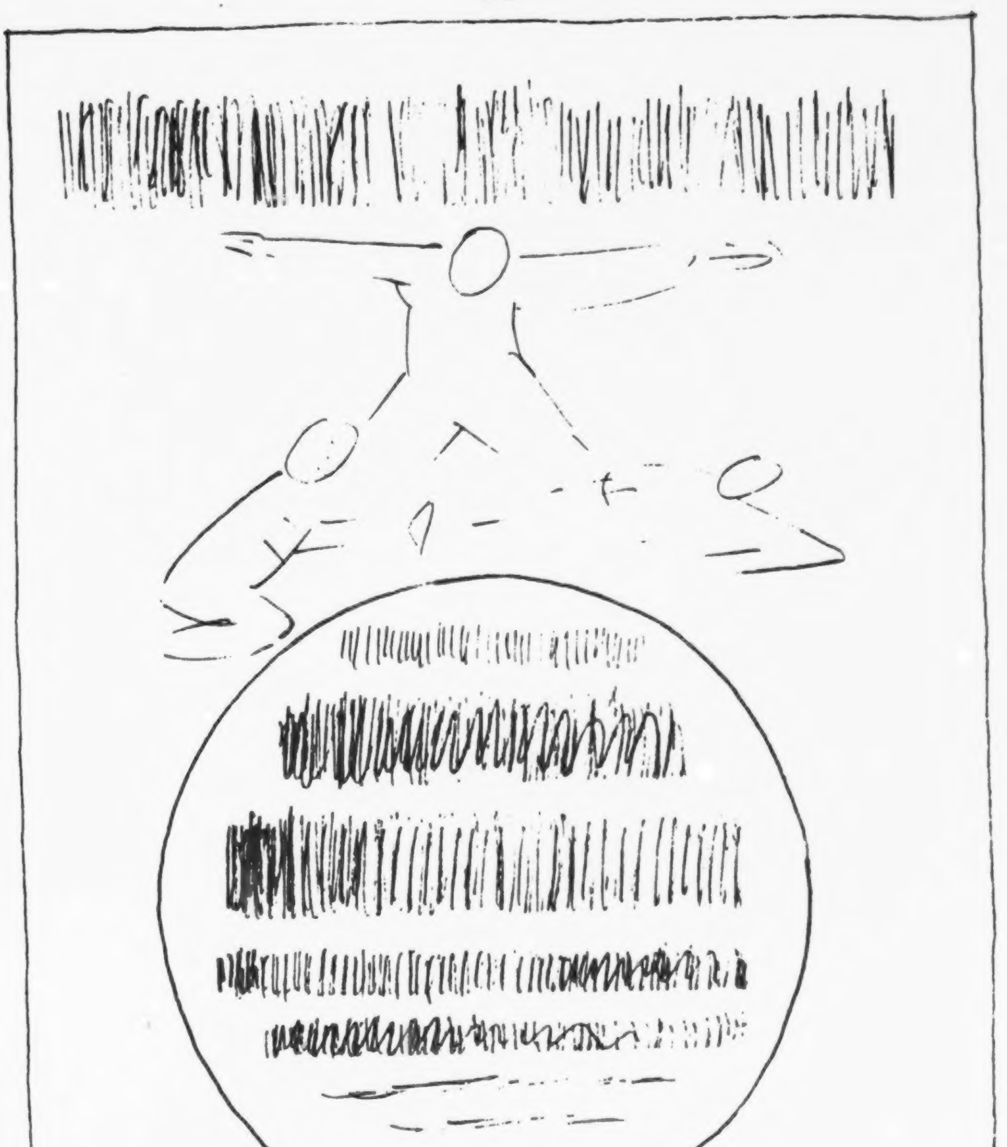

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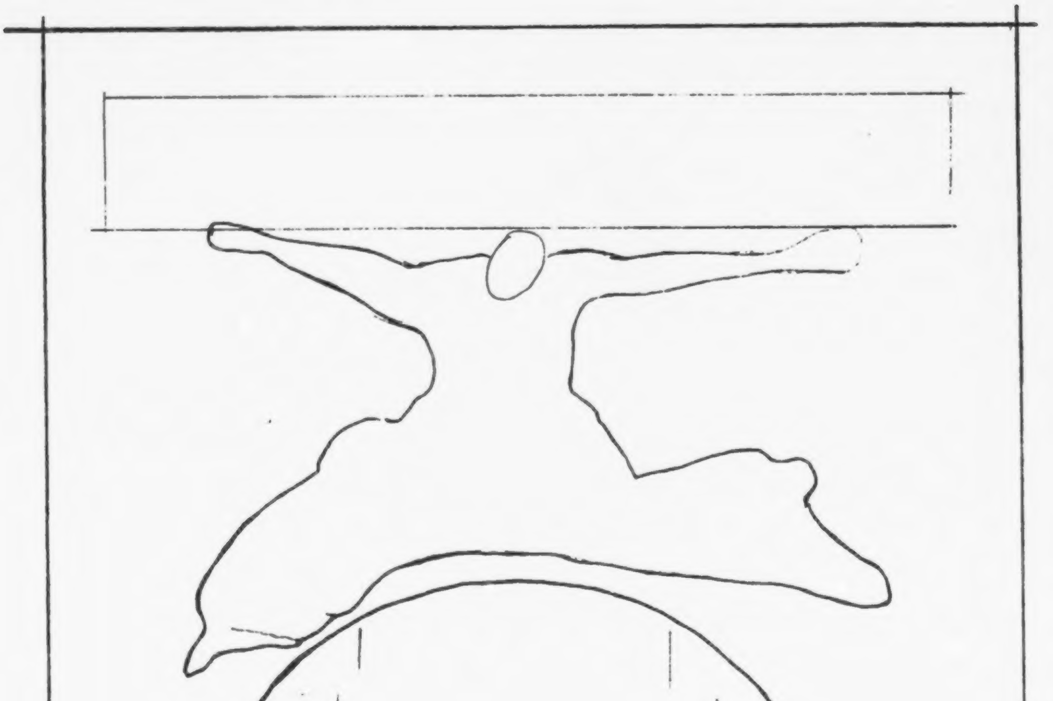
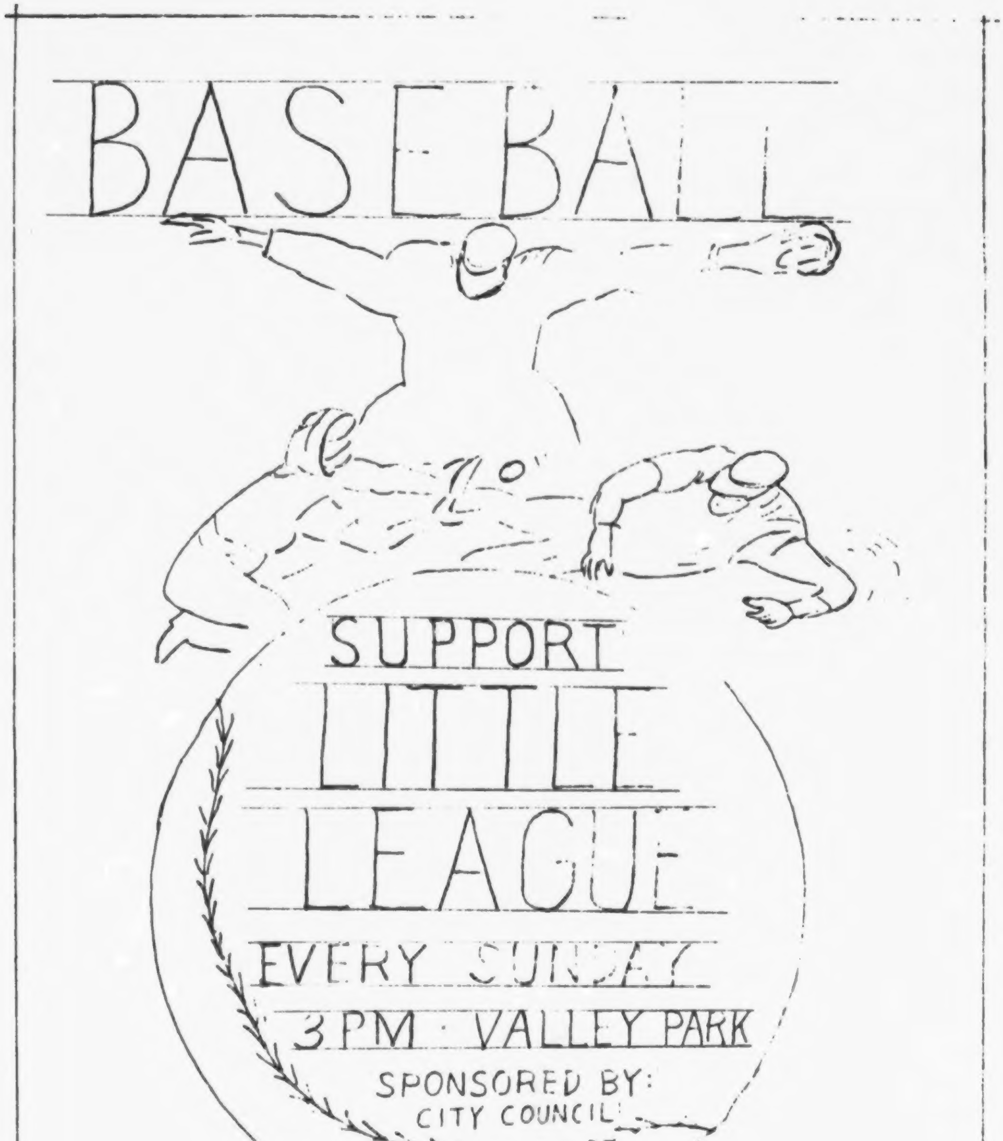


Beginning a rough layout based upon thumbnail sketch.



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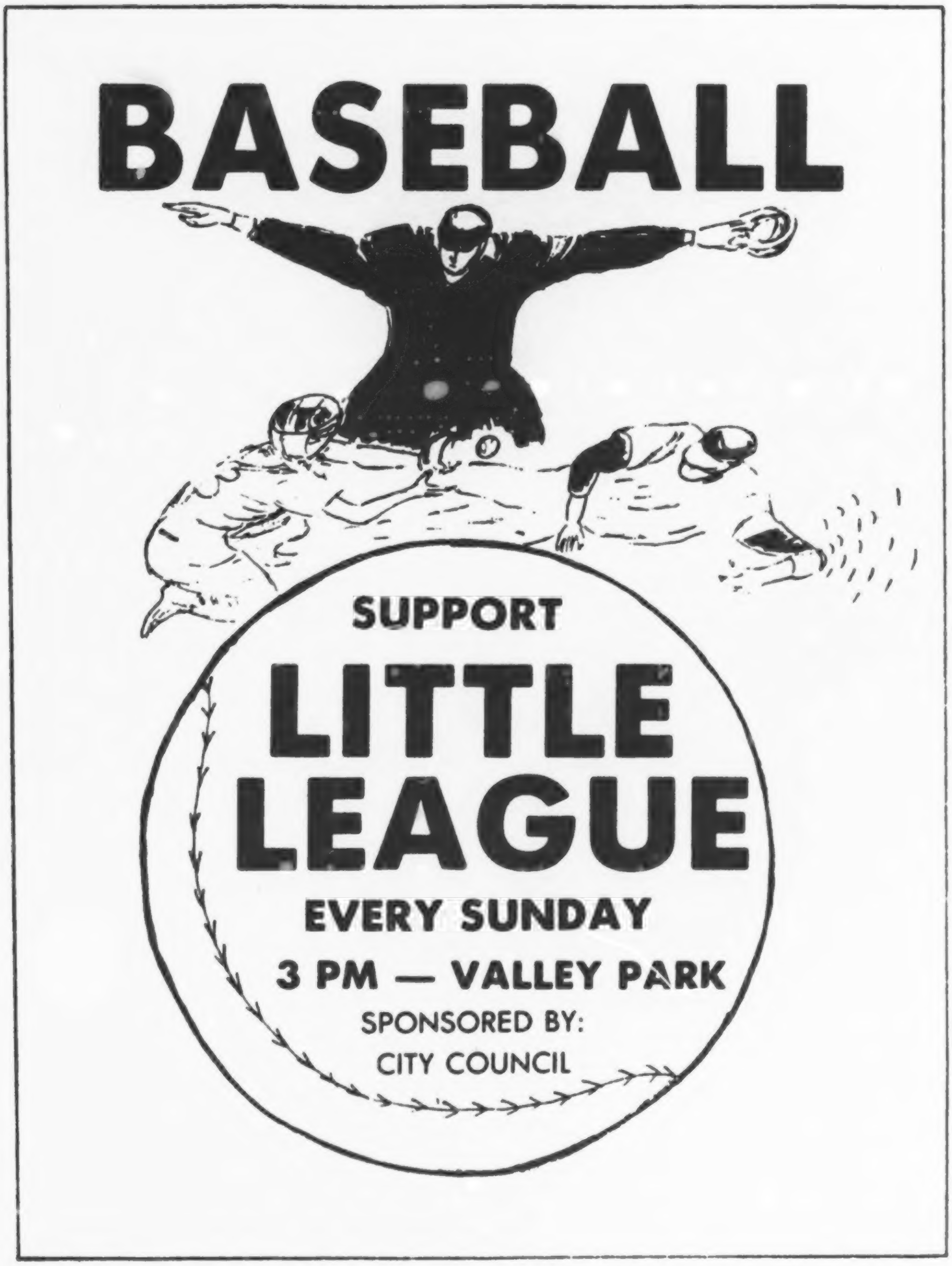

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The first three steps of a comprehensive layout have been completed, based upon the rough layout.

APPENDIX G

ENERGY & POWER MODULE

ENERGY & POWER MODULE

IOWA HIGH SCHOOL INDUSTRIAL ARTS CURRICULUM PROJECT

ENERGY AND POWER: MODULE 1

INSTRUCTOR'S MANUAL

Table of Contents

TOPIC PAGE

I. GENERAL ORIENTATION

A. RATIONAL

B. GOALS AND OBJECTIVES

C. EVALUATION MATERIALS

II. DAILY LESSON PLANS

A. INTRODUCTION TO ENERGY SYSTEMS

B. INTRODUCTION TO SOLAR COLLECTIORS

C. HYDRAULIC SYSTEMS

D. HEAT EXCHANGER SYSTEMS

E. VALVES

F. SOLENOIDS

G. COMPUTER INTERFACING

H. SYSTEM OPERATIONS

I. SYSTEM EXPERIMENTATION

III. CONSTRUCTING THE COLLECTOR SYSTEM

A. ASSEMBLY OF THE FLUID SYSTEM

B. ASSEMBLY OF THE INTERFACE

D. LOADING THE INTERFACE PROGRAM

E. POWERING THE PUMP AND VALVE

F. TESTING THE SYSTEM

ENERGY AND POWER

MODULE 1

by

Members: Industrial Arts Summer
Workshop 1984

Instructor: William G. Miller

IV. EVALUATION MATERIALS

- A. PRE AND POST TEST
- B. PROBLEM WORK SHEETS
- C. STUDENT PARTICIPATION CHECKLIST
- D. ENERGY ATTITUDE SURVEY

INSTRUCTOR'S MANUAL

I. GENERAL ORIENTATION

A. Rational

Welcome to the Integrated Energy Systems Module! This module is designed to help you introduce several major systems concepts to your students. We will cover energy production systems, fluid systems for heat transfer, heat exchange systems, solenoid valves, and computer control systems. We have integrated the above mentioned systems into an overall sytem designed to utilize solar energy. The module may be utilized in a variety of classes ranging from 9th grade to senior level. The minimum time recommended for the unit is two weeks. We have included advanced materials for the student capable of pursuing enrichment material and provided references and media suggestions that could be used by the instructor for a longer time period. We have anticipated the module will be used during the second semester of an introduction to power and energy course or beginning electronics and energy course. This module was developed for the following specific reasons:

a. We have experienced rapid technological changes that affect every citizen. To function as a responsible, informed citizen requires knowledge of the new technologies and appreciation of their impact on individual and collective

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life.

b. There has been a renewed recognition of the importance of science and mathematics concepts to the welfare of society. Industrial technology is the application of science and mathematics concepts and procedures to the transformation of materials and knowledge into useful products. We feel it is absolutely necessary for every student to understand the basic concepts of science and mathematics and have the opportunity to learn them through demonstration of their application.

c. Industrial coursework at the high school level has been taken predominantly by male students. Since females comprise half of the work force and are guaranteed the opportunity to pursue any career, it is important they be provided the same knowledge and skill base of their male counterparts. Curricular materials should be provided that are equally relevant and attractive to both males and females. This module will meet this criterion.

d. Career opportunities and the nature of available jobs is changing rapidly. It is clear that unskilled jobs are rapidly declining and that technical careers and service related careers are increasing. These new opportunities will require more knowledge of technology.

e. Energy demands are currently met mostly through use of fossil fuels. In the past ten years we have become painfully aware of this dependence and the international repercussions of shortages. It is clear that an understanding of alternatives to fossil fuels is important to our survival. This module will contribute to this survival.

We have chosen to package this curriculum material as a 'stand-alone' module. This process was chosen to make it easy to integrate the material into a variety of courses. The material is self-contained, requiring a minimum of preparation and scheduling by the teacher.

The module contains the following major subdivisions or units:

1. Solar Collectors
2. Hydraulic Systems
3. Heat Exchange Systems
4. Valves
5. Solenoids
6. Computer Interfacing
7. System Operations
8. System Experimentation

Your module contains seperate student reading assignments for each of the above units. You will want to read these yourself to be familiar with the content. The module utilizes a demonstration project which the students will assemble and utilize to demonstrate materials learned in the reading assignments. We recommend one unit for each two to three students. The daily lesson plans discussed in

Section II are designed to provide time for your presentations and student work. The student work activities include:

a. Assembly of the demonstration unit.

b. Running computer programs that demostrate energy usage.

computation of subsystem problems, and operation of the demonstration unit.

c. Experiments with the collector system to examine the effects of changes in radiant energy, efficiency of the collector, time lag between the collector and exchanger, etc.

B. Goals and Objectives

The module has the following instructional goals:

1. Provide the opportunity for students to learn:
    - a. Sources of energy
    - b. Principles of Solar Systems
    - c. Principles of hydraulics
    - d. Principles of valves and solenoids
    - e. Principles of systems (input,process, output,feedback)
    - f. Principles of sensors and controllers
    - g. Principles of computer interfacing
    - h. Principles of computer control
    - i. Fabrication and construction of a system

Objectives related to the above goals are summarized in the Lesson Plans Section below.

C. Evaluation Materials

Enclosed in the module package is a packet containing five unit tests and a pretest/posttest. The pretest/posttest is utilized at the beginning and end of the module. Students respond to the test on a standard answer sheet. The instructor's computer disk contains the programs ITEMANAL and RANKER for analyzing the test results and summarizing student scores. (Pilot or test sites will return answer sheets for processing by the Project personnel). Unit tests may be administered in the classroom or self-administered as part of student homework. These tests are designed for instruction rather than evaluation. In addition, paragraphs in the student material have related problems and questions to provide the student with a check on their learning.

II. DAILY LESSON PLANS

Day 1. INTRODUCTION TO ENERGY SYSTEMS

UNIT OBJECTIVES

Following completion of this unit, students should be able to:

1. Identify the approximate years of reserves remaining for fossil fuels
2. Identify at least four sources of renewable energy.
3. Identify at least four ways of reducing fuel consumption.

In addition to the above, the students should have the following attitudes and interests:

1. Anxiety concerning the availability of energy to sustain their present standards of living.
2. Desire to know more about altenative renewable energy resources.
3. Interest in developing a solar collector system.

CLASS ACTIVITIES

A. Pretest (20 minutes)

B. Film (24 minutes)

  a. Energy: New Sources

C. Discussion: The Coming Crisis

a. What is the current rate of fossil fuel consumption?

b. What renewable sources of energy exist?

c. What are the costs to generate electricity using coal, gas, oil, hydroelectric, wind, photovoltaics, atomic, etc.

Day 2. INTRODUCTION TO SOLAR COLLECTORS

UNIT OBJECTIVES

Following compeletion of this unit, students should be able to:

1. Differentiate between and describe passive and active solar collectors.
2. Identify and correctly use terminology used in measuring solar energy.
3. Describe the construction and operational principles of a solar collector panel.
4. Load and execute computer programs related to the energy module.
5. Measure solar radiation and convert these measures to English and Metric measures of energy production.

In addition, the student should:

1. Achieve an increased interest in the relationship between solar radiation and heat gain.
2. Enjoy solving real-life problems through simulation of events and processes on a computer.
3. Desire to participate in the construction and testing of a solar collection system.

CLASS ACTIVITIES:

A. Presentation (15 minutes): Principles of Passive and Active Solar Collectors

   - a. Transparency: A Passive Collector System
   - b. Transparency: An Active Collector System
   - c. Transparency: Angle of Incidence
   - d. Transparency: Construction detail of an Active Collector Panel

- B. Simulation (15 minutes): Playing the Energy Survival Game
   - a. Loading "SURVIVAL" on the computer
   - b. Game objectives
   - c. Discussion of Implications

- C. Exploring the Integrated System Demonstration Unit (15 minutes)
   - a. Inventory of parts
   - b. The Construction Directions
   - c. Schedule of Completion Activities

Day 3. HYDRAULIC SYSTEMS

UNIT OBJECTIVES:

Following completion of this unit, the student should be able to:

1. Define hydraulics.
2. Describe systems which utilize hydraulics and the major components of these systems.
3. Describe major advantages and disadvantages of hydraulic systems.
4. Describe the potential hazards to personal safety when working with hydraulic systems.
5. Utilize algebraic relationships among measures of fluid pressure, cylinder diameter, piston force and rotor torque.

In addition, the student should:

1. Respect the importance of safety precautions and practices in working with hydraulic systems.
2. Desire to know the relationship between flow rate and pump pressure and solar collector operations.
3. Achieve an increased interest in possible alternative uses of hydraulic systems where electro-mechanical systemsare currently used.

CLASS ACTIVITIES:

A. Presentation (15 minutes): How Hydraulic

Systems Work

- a. Transparency: Gear Pump
- b. Transparency: Rotorary Pump
- c. Transparency: Single Acting Cylinder
- d. Transparency: Double Acting Cylinder
- e. Transparency: Axial Piston Motor

B. Demonstration Unit Assembly (30 minutes)

- a. Assembly of the Collector Panel
- b. Assembly of the fluid lines
- c. Assembly of the pump and valve
- d. Testing the pump

Day 4. HEAT EXCHANGE SYSTEMS

UNIT OBJECTIVES:

Following completion of this unit, students should be able to:

1. Distinguish between open loop and closed loop solar systems.

2. List three common devices that use heat exchangers.

3. Distinguish between recuperative and regenerative heat exchangers.

4. Identify and distinguish drawings of the following heat exchange systems: single-pass, multi-pass, counterflow, crossflow, tube and shell, tube and fin, mixed and unmixed.

5. Explain the basic operation of a heat pump.

6. Describe how heat exchangers are used in solar systems.

7. Define and correctly use the following terms: fluid, conduction, heat exchanger.

8. Calculate the number of BTU's transferred in a heat exchanger, given the temperature change and the volume of water affected.

9. Calculate the number of calories (and Calories) transferred in a heat exchanger, given the temperature change and the volume of water affected.

In addition to the above, the student should:

1. Increase in their appreciation of the importance of

mathematics in designing and operation of solar collector systems.

2. Achieve an increase in interest in utilizing a computer to make calculations related to heat exchangers and collector systems.

3. Have an increased desire to make practical measures of a solar collector system to apply theories of operation.

CLASS ACTIVITIES:

A. Principles of Heat Exchangers (15 minutes)
  a. Transparency: Tube Construction Exchanger
  b. Transparency: Fin Construction Exchanger
  c. Transparency: Automotive Heat Exchangers
  d. Transparency: Heat Pump

B. Design of Heat Exchangers (15 minutes)
  a. Mathematical Relationships in heat exchange
  b. Loading Computer Programs for Calculation
  c. BTU's or Calories Required for a change in temperature of a volume of liquid
  d. Heat Exchanger Effectiveness calculations

C. Demonstration Unit Assembly (15 minutes): The Heat Exchanger
  a. Coiling the Copper Tubing
  b. Preparing the Copper Foil
  c. Combining Tubing and Foil

d. Selecting a Medium of Exchange
(air or water)

REFERENCES:

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Day 5. VALVES

UNIT OBJECTIVES:

Following completion of this unit, the student should be able to:

1. Match terms related to valves with their correct definitions.
2. Name three categories of valves.
3. Name three types of pressure control valves.
4. Name the types of pressure relief valves when given a description of their operations.
5. List three types of flow control valves.
6. Identify types of directional control valves.
7. Distinguish between the operation of a check valve and a spool direction control valve.
8. Match terms related to lines, fittings, and couplers with the correct definitions.
9. Discuss the types, construction, size and characteristics of steel pipe and tubing.
10. Identify types of fittings commonly used with tubing and hoses.
11. Select factors to consider and conditions to avoid when routing hydraulic hose.
12. Distinguish between open center and closed center systems.

CLASS ACTIVITIES:

A. Presentation (15 minutes): Valve Construction

  a. Transparency: Pressure Relief Valves

  b. Transparency: Needle Valve

  c. Transparency: Pressure Compensated Flow Control Valve

  d. Check, Rotary and Spool Valves

  e. Hydraulic Couplers

B. Simulation (15 minutes): Fluid System Control With Valves

  a. Loading the FLUIDICS program

  b. Simulated Flow With No Load

  c. Simulated Flow With a Load

  d. Simulated Overload

C. Demonstration Unit Assembly (15 minutes)

  a. Assembly of the Heat Sensor Unit

  b. Assembly of the Computer Interface

  c. Attaching the solenoid and pump to the interface

Day 6. SOLENOIDS

OBJECTIVES:

Following completion of this unit, the student should be able to:

1. Describe five applications of solenoids and solenoid valves.
2. Describe the principles of operation of a solenoid.
3. Calculate the ounces of tourque or pressure of a solenoid given the diameter and length of the coil, the core material, the voltage of the supply and the resistance of the coil wire.
4. Describe the application of solenoid valves in down-drain types of active solar collectors.

CLASS ACTIVITIES:

A. Presentation (10 minutes): How the Solenoid Operates
   - a. Transparency: A Solenoid Valve
   - b. Transparency: Applications of Solenoids
   - c. Transparency: Relationships among voltage, coil diameter, length of coil, and foot-pounds of force generated

B. Demonstration Unit Construction (20 minutes)
   - Construction of the Power Supply

  b. Attaching the Power to the Interface
  c. Loading the Interface Test Program
  d. Testing the Solenoid and Pump Control

C. Operation of The Integrated Energy Unit
  a. Arranging the Collector and Light Source
  b. Loading the ENERGY SYSTEM Computer Program
  c. Observing Flow Rates and Temperature Changes

Day 7. COMPUTER INTERFACING

UNIT OBJECTIVES:

Following completion of this unit, the student should be able to:

1. Convert an 8-bit binary number to a decimal number.
2. Describe the purpose of an analog to digital convertor.
3. Describe the purpose of a digital to analog convertor.
4. Describe the characteristics and uses of a solid state or solenoid microrelay.
5. Describe the operation of a thermistor and the measurement of heat with a thermistor and computer.
6. Outline the procedures for calibration of a thermistor/computer system.
7. Construct BASIC language statements to print the value of a memory byte.
8. Construct BASIC language statements to turn specific memory bits off or on at a user port of a computer.

In addition to the above, the student should:

1. Achieve an increased interest in the use of computers for control of external processes.
2. Respect the importance of correct wiring to a computer to minimize potential damage to the equipment.
3. Increase in self-confidence to utilize a computer in

real-time processes.

4. Increase their enjoyment of computer programming and computer usage.

CLASS ACTIVITIES:

A. Presentation (25 minutes): Principles of Computer Control

  a. Transparency: A Home Heating/Cooling System

  b. Transparency: Binary Representation of Decimal Values

  c. Transparency: Converting Measured Voltage Values to Binary Numbers

  d. Transparency: Microswitch Relays Controlled by a Binary Port

  e. Transparency: Selecting a Byte to Turn off or on a Microswitch

B. Program Demonstration Activity (25 minutes): System Calibration

  a. Load the SENSOR CALIBRATE program.

  b. Place the thermistor in ice.

  c. When temperature has stabilized, enter 0 degrees (Celcius) at prompt for low value.

  d. Place thermistor in boiling water. When stable readout is obtained, enter 100 for high value.

e. Load ENERGY SYSTEM program. Place the thermistor back in the ice and run program.

Day 8. SYSTEM OPERATIONS

UNIT OBJECTIVES:

Following completion of this unit, the student should be able to:

1. Setup the collector system for operation.
2. Calibrate the system heat sensor.
3. Load and execute the computer interface program.
4. Describe the interrelationship among system temperature and system operation of the solenoid and pump.
5. Make basic measurements of solar insolation, fluid heat capacity, temperature changes and system efficiency.

In addition, the student should achieve:

1. An appreciation of automation as it is applied to an energy production system.
2. An interest in improving and adapting the interface of computers to real-time processes.
3. A desire to maximize the efficient use of collector systems.
4. An appreciation for rigor in observing and recording data observations.

A. Demonstration (15 minutes): Initial Setup
   a. Check fluid levels and connections.
   b. Turn on Power Supply.
   c. Turn on computer and load ENERGY SYSTEM

d. Check calibration of thermistor against room thermometer.

e. Place heat lamp two feet from collector at perpendicular angle.

f. Record temperature changes per unit of time on graph paper.

g. Record temperature at which system turns off and drains down.

B. Observation and Data Collection.

a. Measure photovoltaic output at collector for different light source distances, and angle of incidence.

b. Plot temperature of collector against changes in lightmeter output in (a) above.

c. Measure the elapsed time btween collector temperature stabilization and the exchange fluid temperature stabilization.

d. Calculate the theoretical Calories required to raise the exchange fluid 20 degrees.

e. Calculate the Calorie equivalent of electricity used by the heat lamp to raise the exchange temperature 20 degrees.

f. Calculate the ratio of the theoretic calories and used calories. What is the system efficiency?

Day 9. SYSTEM EXPERIMENTATION

UNIT OBJECTIVES:

Following completion of this unit, the student should be able to:

1. Describe in words and using algebra, the relationships between solar insolation, collector temperature, initial temperature of fluid, heat capacity of a fluid, flow rate, rate of heat exchange and system efficiency.
2. Make systematic observations on the operation of a collector system and plot the relationships among the variables.
3. Design experiments to examine the effects of specified variables on solar collector system efficiency.
4. Extrapolate observations and relationships observed on the demonstration unit to larger units.
5. Design a home solar collector system to meet specified energy requirements.

In addition to the above, the student should achieve:

1. An appreciation for experimental and scientific procedures.
2. An appreciation for the limits, costs and complexities of alternative energy systems.
3. An increased interest in inventing and discovering more effective methods for utilizing solar energy.

CLASS ACTIVITIES:

A. Experiments with Heat Source

a. Determine BTU gain for various fixed distances of light from collector panel.

b. Determine BTU loss between the collector panel and exchange fluids.

c. Determine the flow rate of the pump and assess the effect of flow rate on rate of heat exchange.

d. Estimate the heat obtainable from a similar collector 4 by 8 feet in size.

e. Determine the square foot of collector area need to raise water in a home water heater from 55 degrees farenheit to 180 degrees farenheit.

Day 10. SUMMATIVE EVALUATION

UNIT OBJECTIVES:

Following completion of this unit, the student will:

1. Disassembled and repacked the Demonstration Unit components.
2. Completed a posttest of cognitive knowledge obtained from the module.
3. Completed and turned in the worksheets utilized during the module.
4. Completed an affective measure of attitudes and values influenced by completion of the module.
5. Completed an evaluation of the project reading materials, instructor presentations, computer activities and Demonstration Unit construction activities.

CLASS ACTIVITIES:

A. Post Test Administration (20 minutes)

B. Affective Outcomes Assessment (10 minutes)

C. Module Evaluation (5 minutes)

D. Collection of Worksheets (5 minutes)

E. Disassembly and Repack (15 minutes)

III. CONSTRUCTING THE COLLECTOR SYSTEM

A. ASSEMBLY OF THE FLUID SYSTEM

The Fluid System portion of the demonstration unit consists of a flat plate panel, tygon tubing to connect parts, a solenoid valve to open or close fluid flow, a water pump and fluid reservoir, and a copper coil submerged in fluid for heat exchange.

The flat panel consists of three copper tubes soldered to one-side printed circuit board. The collector plate should be painted flat black following soldering of the tubes to the board. The tube ends are inserted through holes bored in the frame ends and the other two frame sides nailed in place. An extra hole exists for insertion and removal of a thermistor used to measure collector temperature. Tygon tubing is used to connect the collector tubes for serial or parallel flow (tees must be used to create a parallel manifold). The entire panel may be attached to the top of the insulated unit box. The angle of the box lid may be varied for experiments concerning light angle of incidence. Figure 1 presents an exploded view of the panel.

Tygon tubing is run from the panel top side to the outlet side of the solenoid valve. The inlet side of the valve is connected to the pump outlet. The pump should be firmly mounted inside the demonstration box. Place the solenoid at least 3 inches from the pump and oriented with the lead wires pointing up (these will be connected to the interface harness). The reservoir is an integral part of the pump. It should be filled with a measured amount of fluid prior to operation of the pump.

The bottom side of the collector panel should be attached to tubing which runs to the heat exchange coil. The exchange coil consists of two feet of copper tubing wound to approximately a 3 inch diameter. The coil is submerged into the heat exchange fluid contained in a plastic bag or bottle. The other end of the coil is attached to tygon tubing which runs back to the reservoir. An alternative heat exchanger is the air exchange unit which consists of a 12 inch length of copper tubing inserted through folds of copper foil. The pump, solenoid valve, fluid heat exchanger and panel connections are illustrated in Figure 2.

B. ASSEMBLY OF THE INTERFACE

The computer interface consists of a perforated printed circuit board, two solid state relays, a 48 pin female connector for the Commodore VIC or C64 user port, 4 plastic wire nuts, 24 feet of wire, a thermistor, a 3 pin "joystick" port connector and plastic wire harness. Figure 3 illustrates the wiring between the 48 pin connector, the solid state relay, the power supply (to be described below), and the solenoid and pump. Care must be exercised to wire correctly between the solid state relays and the designated pins of the connector. Figure 4 illustrates the connection of the 9 pin connector and the thermistor. The thermistor must be encapsulated in a sealed vial to prevent shorting from water immersion. Joystick port 2 of the Commodore (if used) is used as the input point for the 9 pin plug. Be careful to connect the appropriate leads to prevent damage to your computer. There will be variance from computer to computer on sensitivity to the range of resistance of the thermistor over operating temperatures. For this reason, the programs used to test and operate the system provide for calibration of the thermistor.

C. LOADING THE INTERFACE PROGRAM

The Interface program exists as a subroutine in two programs: INTERFACE TEST and ENERGY SYSTEM. The subroutine handles the PEEKing and POKEing of the memory bytes associated with the user ports. Port B of the Commodore computer or Vic computer is utilized to turn off or on the pump and the solenoid. Bits 0 and 1 are used respectively. The analog to digital convertor of the game paddle X byte is used for input of the varying resistance of the thermistor. Since thermistors and their associated leads may vary in addition to the variability found from computer to computer, it is necessary to calibrate the thermistor values. Two temperatures are used, the freezing and boiling temperatures of water. The byte values obtained from the resistance measured at those two temperatures determines the range and precision of the thermistor. A linear translation and interpolation of those values is done to the farenheit and celcius scales. The computer programs repeatedly read the paddle port and report the temperature on the screen unless a key is pressed on the keyboard of the computer. When a key is pressed, a menu routine is displayed for selection of appropriate activities. To continue reading the temperatures, the user must select the continuous operation option from the menu. The solenoid and pump are deactivated when the measured temperature falls below 35 degrees farenheit or above 200 degrees farenheit. These values however may be changed to test operation of the system at a more narrowly defined range of operation.

Before turning on the computer and loading of a program, turn on the power supply to the interface, pump and solenoid. This will avoid any voltage surges which may damage the computer or program. It is imperative that the voltages be measured at the pins of the interface to check your wiring before turning on thecomputer. Be sure all wiring is carefully insulated and dressed to avoid short circuits. When you are assured that the wiring is correct and supply voltages correct, turn on the disk drive, printer, screen and then the computer. Place the ENERGY SYSTEMS disk in the drive and type LOAD "TEST",8 or LOAD "ENERGY SYSTEM",8 . Press the return key. When the light on the drive turns off, type RUN and press the return key. Select the option desired from the menu displayed on the screen.

When you are finished testing or running the system, turn off the computer first. Next turn off the computer peripherals (printer, screen disk drive). Finally, turn off the power supply to the interface, pump and solenoid.

E. POWERING THE PUMP AND VALVE

The power supply for the interface, pump and solenoid consists of a step-down transformer (117v to 12v), and a full-wave bridge rectifier. The unregulated 12 volt DC is used to power the solenoid and pump. These circuits are activated by the secondary circuit (switch) of the solid state relay which is controlled by bits 0 and 1 of the User Port B of the computer. Figure 5 illustrates the assembly of the power supply and Figure 6 presents the electronic diagram of the circuit. The rectifier and transformer are mounted together with a heat sink in an eclosure. Four color-coded wires lead from the supply for attachment to the interface and collector devices. The red and green wire are wired in series with the secondary of the solid state relay and the water pump. The orange and black wires are wired in series with the second (bit 1) relay and the solenoid.

When assembling the power supply and attaching power leads to the relays and collector devices, make sure all solder joints are mechanically tight and insulated from each other. Plug in the transformer primary and check voltage levels accross both pairs of secondary leads. Do this before attaching the power leads to the interface and devices. Following attachment to the relays and devices, again check the supply at those points. Do not powerup the computer until you are satisfied that power leads are correctly placed, well soldered and insulated. You may test the solenoid and pump without the use of the computer by temporarily placing a jumper wire accross the pins where the power wires are attached to the relays.

F. TESTING THE SYSTEM

When you have completed the assembly of all parts, mounted them in the demonstration unit box and tested the individual components, you are ready to operate the system. To accomplish this, you will need to fill the reservoir with water, place the thermistor in ice, turn on power to the power supply, turn on the computer and load the TEST program. When this has been accomplished, select the "calibrate" option of the program and then select the "low" option. Wait approximately five minutes for the values printed to the screen to stabalize. Press a key to return to the menu and select calibrate and the "high" option. Place the thermistor in boiling water and wait for the values printed on the screen to stabalize. Press a key to return to the menu and select the "collector" option. Place the thermistor in the hole in the collector panel. Wait for the temperature displayed on the screen to stabalize. Compare the values displayed against a room thermometer. If the difference is greater that 10 degrees, press a key to get the menu and select the "set point" option. Now enter the actual thermometer reading of the collector into the keyboard and press return. Press a key to return to the menu and select the "new range" option. This option will request two temperatures, a low and a high. Enter a value for the low temperature that is 10 degrees (farenheit) higher than the current collector temperature. For a high value, enter a value that is 30 degrees higher than the current temperature. Press a key to return to the main menu.

Plug in the heat lamp provided with your demonstration unit. Place it approximately two feet in front of the collector panel and turn it on. As the system reaches the new low temperature selected, the pump and solenoid should automatically begin to operate. Continue to let the lamp heat the panel. When the temperature exceeds the new top value, the system should automatically disable the pump and solenoid. Turn off the lamp and let the system cool. As it cools the system should again become active until the temperature falls below the new low. You may notice that the nominal low and high values are exceeded by a value approximately equal that of the calibration precision. When all tests are completed, remove the program disk, turn off the computer peripherals and computer, turn off the power supply, and drain the system of water.

IV. EVALUATION MATERIALS

This section contains the Pre/Post Concept Mastery Test, the Affective Outcomes Assessment, the Module Evaluation Form and the Daily Worksheet Packets (5). The Concept Mastery test is administered both Day 1 and Day 10. Two computer-readable answer sheets are provided for this test. The Affective Outcomes Assessment is administered during Day 10. A seperate form is used by students for this instrument. The Module Evaluation Form is administered day 10 and has its own answer sheet. Pre and Post Concept Mastery Test forms, Affective Assessment forms and Module Evaluation forms are returned to the Project Office in the envelope provided following day 10. The Daily Worksheet Packet material is retained by the instructor and may be used for general course grading practices. Scores obtained on the Post Concept Mastery Test will be sent to the instructor for use in course grading also.

INTEGRATED ENERGY SYSTEMS

CONCEPT MASTERY TEST

DIRECTIONS:

Attached to this test is an answer sheet on which you will record your responses. Please print your name, age, gender, the current date, grade level, instructor's name and school name in the areas provided. DO THIS NOW!

Each of the statements below have one correct or best answer. Each of the possible answers has a letter A,B,C,D or E. You will record the letter corresponding to your best choice on the answer sheet. Find the number on the answer sheet corresponding to the statement and record the letter of your choice.

You will have 20 minutes to complete the exam. GO AHEAD.

1) The best description of a solar collector is;
   a) A box that gets hot when the sun hits it.
   b) A device that heats your house with sun.
   c) A device that captures radiant energy and isolates it from the surrounding environment.
   d) A device that captures only sunlight and isolates it from the surrounding environment.

2) Early references in writing that refer to using the sun's heat to warm structures date back to;
   a) 400 B.C.
   b) 800 A.D.
   c) Only during the last century.
   d) Only the last 40 years.

3) The sun's heat reaches the earth by a type of energy transfer called;
   a) Conduction.
   b) Convection.
   c) Radiation.
   d) None of the above.

4) Heat energy transfer between two solids that are in physical contact with one another is called;
   a) Conduction.
   b) Convection.
   c) Radiation.
   d) None of the above.

5) Heat energy transfer between a solid and a fluid is called;
- a) Conduction.
- b) Convection.
- c) Radiation.
- d) None of the above.

6) The part of a solar collector that allows the sun's energy to enter is called the;
- a) Glass.
- b) Air space.
- c) Glazing.
- d) Port.

7) The part of a solar collector that heats up the most as the sun enters is called the;
- a) Absorber.
- b) Plate.
- c) Enclosure.
- d) None of the above.

8) The sun's heat energy comes in the form of;
- a) Visible light.
- b) Infared light.
- c) Ultraviolet light.
- d) All of the above.

9) The sun produces its energy from;
- a) Thermonuclear fusion.
- b) By turning matter into energy.
- d) None of the above.

10) The part of a solar collector that keeps the collected energy from escaping into the outside environment is called the;
- a) Box.
- b) Radiator.
- c) Enclosure.
- d) Any of these terms could be used to describe it.

11) The part of the solar collector that admits the sun's energy should have a maximum amount of;
- a) Reflectivity.
- b) Absorbtion.
- c) Transmission.
- d) Conduction.

12) What surface would get the hottest when placed in direct sunlight;

a) A dull, white surface.
b) A shiny, white surface.
c) A dull, black surface.
d) A shiny, black surface.

13) What material would allow the maximum amount of the sun's heat energy to pass through it;

a) Wood.
b) Glass.
c) Clear plastic.
d) b and c would be nearly equal.

14) The principle that allows the sun's heat energy to be trapped inside cars and builds by their glass surfaces is commonly called;

a) The greenhouse effect.
b) Newton's law.
c) The principle of thermosyphoning.
d) Both a and b.

15) All areas in the northern hemisphere should have their solar collectors facing;

a) Exactly north.
b) Exactly south.
c) Northeast.
d) Either north or south depending on the locality.

16) How does the sun's path through the sky differ from winter to summer;

a) It sweeps across the sky higher in the summer.
b) It sweeps across the sky higher in the winter.
c) It settles more to the west in the summer.
d) It is the same winter and summer.

17) In Iowa, which is about 40 degrees north latitude, a solar collector should be tilted at what angle for the best year round average performance;

a) 20 degrees.
b) 30 degrees.
c) 40 degrees.
d) 50 degrees.

18) The two fluids most commonly used to take heat energy from a solar collector are;

a) Oil and water.
b) Water and air.
c) Water is the only fluid commonly used.
d) None of the above.

19) Assuming that we have a well-designed solar collector, the most important thing effecting its performance as we use it on a clear, sunny day would be;

a) The amount of fluid passing through it.
b) Its orientation to the sun.
c) The outside temperature.
d) a and c would be equally important.

20) The structure that encloses the working parts of a solar collector should have a maximum of;

a) Conduction.
b) Reflection.
c) Insulation.
d) b and c.

21) Which of the following would improve the performance of a solar collector;

a) A tracking device so that the collector would always be faced directly into the sun.
b) Mirrors to reflect additional light into the front of the collector.
c) Both a and b would improve it.

22) Pump	a) A device which converts hydraulic energy into mechanical energy.
23) Motor	b) An actuator which creates rotary motion.
24) Cylinder	c) A device which controls fluid flow.
25) Actuator	d) A device that creates fluid flow
26) Valve	e) An actuator that creates linear motion.

27) Line	a) The study of fluids in motion or at rest.
28) Fluid	b) A substance which has no shape of its own.
29) Hydraulic	c) A device which removes contamination.
30) Reservoir	d) A container for holding a fluid supply.
31) Filter	e) A tube, pipe, or hose for conducting a fluid.

32) A real-time process refers to:
- a) A digital clock.
- b) A process for measuring continuous time.
- c) An activity which operates continuously.
- d) A computer simulation of activities that really occur.
- e) A digital to analog convertor.

33) A house thermostat is
- a) An analog control device.
- b) A digital control device.
- c) An analog to digital convertor.
- d) A digital to analog convertor.
- e) None of the above.

34) An integrated circuit used in computers that is called a 'driver':
- a) is used to turn external circuits off or on.
- b) is used to convert 12 volt DC to 5 volt DC.
- c) is used to direct current flow into multiple binary gates.
- d) is used to convert binary to decimal values.
- e) increases current delivery in a digital circuit.

35) When it is desirable to isolate a computer circuit from another circuit, you can use
- a) An opto-isolator circuit.
- b) A driver circuit.
- c) An op-amp circuit.
- d) A transformer.
- e) A logical gate.

36) Thermistors are used to:
a) Raise the temperature of a device.
b) Measure temperatures of a device.
c) Calibrate a thermometer.
d) Increase heat flow in a conductor.
e) None of the above.

37) Which of the following device converts alternating current to direct current?
a) Thermistor.
b) Driver.
c) D/A convertor.
d) Rectifier.
e) Opto-isolator.

38) As light intensity increases on the surface of a photovoltaic cell,
a) The cell resistance increases.
b) The cell generates a higher voltage.
c) The cell begins to shut down.
d) The cell generates more current.

39) An analog to digital convertor approximates a signal by
a) chopping the analog signal into many parts.
b) approximating voltage levels with binary values.
c) holding a voltage for a short time until conversion is complete.
d) all of the above.
e) none of the above.

40) One cycle of a 100 cycle per second signal takes how long?
a) 100 seconds.
b) 1 second.
c) .1 second.
d) .01 second.
e) .001 second.

41) A computer port is that part of a computer that
a) transmits binary signals to external devices.
b) transmits analog signals to external devices.
c) processes machine instructions.
d) that randomly accessible binary values.
e) Both C and D above.

42) In most computers, a binary value 1 is represented by
- a) a -12 volts DC
- b) a +12 Volts DC
- c) a 0 volts DC
- d) a +5 volts DC
- e) None of the above

43) Sensors are devices that measure real-time process and typically produce
- a) An analog signal
- b) A digital signal

44) The typical automobile radiator is an example of a:
- a) heat pump
- b) shell and tube heat exchanger
- c) tube and fin heat exchanger
- d) double pipe heat exchanger

45) The drawing below represents:
- a) a counterflow heat exchanger
- b) a cross flow heat exchanger
- c) a heat pump
- d) a tube and shell heat exchanger

46) The term fluid refers to:
- a) a gas
- b) a liquid
- c) either a gas or liquid
- d) mater in any state (phase)

47) A heat pump contains
- a) a condensor
- b) an evaporator
- c) both a condensor and evaporator
- d) neither a condensor nor evaporator

48) The use of a rock storage system as a matrix with a solar collector is an example of a:
  a) recuperative exchanger
  b) regenerative exchanger
  c) heat pump
  d) tube and shell exchanger

49) Heat energy passes through a wall most effectively by means of:
  a) radiation
  b) convection
  c) conduction
  d) osmosis

50) Which of the following may be thought of as a heat pump?
  a) a tube and shell exchanger
  b) a gas furnace
  c) a refrigerator
  d) an automobile radiator

51) Which of the following is inefficient and thus unlikely to be found in a solar collector system?
  a) a parallel flow heat exchanger
  b) a counter flow heat exchanger
  c) a heat pump
  d) a heat sink

52) Which of the following is NOT true of an open loop solar collector system?
  a) It usually carries an antifreeze solution.
  b) It is generally more efficient than an equivalent closed loop system.
  c) There is no heat exchanger involved.
  d) The collector fluid is drawn from the bottom of the storage tank.

53) Which of the following is NOT true of a recuperative system?
  a) Has alternating hot and cold fluids passing through a matrix.
  b) Hot and cold fluids pass through seperate paths.
  c) Heat passes through walls.
  d) It is exemplified by the shell and tube heat exchanger.

54) The medium warmed be a heat pump is called
- a) a heat sink
- b) a heat source
- c) an insulator
- d) a heat exchange receiver

55) A 150 liter solar assisted hot water heater has a heat exchanger built into the system. The temperature of cold incoming water is 15 degrees centigrade. The temperature of water (before receiving a boost from the natural gas supply) is 35 degrees centigrade. What is the total amount of energy given to the water?
- a) 3000 standard thermal units
- b) 7.5 BTU's
- c) 5250 Calories
- d) 3,000,000 calories

56) In a heat exchange system, which of the following will NOT cause a greater heat transfer?
- a) decreasing the density of the fluids in the system.
- b) increasing the flow velocity of the fluids
- e) the use of fins to increase surface area
- f) creating a laminar flow in one of the fluids

57) A device used to control fluid flow:
- a) actuator
- b) pump
- c) valve
- d) swivel

58) A device used to change fluid energy to mechanical energy:
- a) actuator
- b) pump
- c) valve
- d) swivel

59) A pump whose inlet is hydraulically connected to the outlet for fluid recirculation when the pressure builds up:
- a) nonpositive displacement pump
- b) positive displacement pump
- c) actuator pump
- d) cavitation pump

60) A rotary actuator is
  a) a hydraulic cylinder
  b) a screw pump
  c) a hydraulic motor
  d) none of the above

61) A positive displacement pump is
  a) a gear type pump
  b) a vane type pump
  c) a screw type pump
  d) all of the above types

62) A cyclinder may be
  a) single action or double action
  b) linear action or rotory action
  c) positive displacement or nonpositive displacement
  d) none of the above

63) Hydraulic motors
  a) change fluid energy into rotary motion
  b) change fluid energy into linear motion
  c) create fluid flow
  d) pressurize the fluid power system

64) A device that provides th initial power to a fluid power system is the
  a) motor
  b) pump
  c) prime mover
  d) actuator

65) The primary function of hydraulic fluid is
  a) lubricate parts
  b) transmit heat
  c) transmit power
  d) seal component parts

66) Hydraulic fluid
  a) may be caustic to the skin
  b) may be flammable
  c) May operate at 225 degrees F. d) All of the above

INTEGRATED ENERGY SYSTEMS

AFFECTIVE OUTCOMES ASSESSMENT

DIRECTIONS:

Attached to this instrument is an answer sheet on which you will record your responses. Please print your name, age, gender, the current date, grade level, instructor's name and school name in the areas provided. DO THIS NOW!

Each of the statements below is neither correct nor incorrect. You are simply asked to indicate how strongly you agree or disagree with each statement. On the answer sheet there are five numbers for each item. If you strongly disagree with an item, darken the 1. If you strongly agree, darken the 5. Marking 3would indicate you neither agree nor disagree. You may use any number from 1 to 5. Do not think about your answer too long. You have 10 minutes to complete the instrument. Go ahead.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor	Agree	Strongly Disagree

1. While we talk about an 'energy crisis' I really don't think there is one.

2. By the time we run out of fossil fuels, some new fuel not yet invented will be available.

3. Solar energy is quite practical right now.

4. I really want to encourage my parents and friends to consider solar systems for their homes.

5. If I were to go into the manufacturing business, I'd probably build solar systems.

6. I've been thinking about how I could use microcomputers to control several things around the house.

7. I think this country is in big trouble if it doesn't start to do serious research on renewable energy sources.

8. Many practical collector systems can be built from low cost materials.

9. I enjoy designing a car in my head that would use hydraulic drive instead of mechanical drive.

10. Girls don't have to worry about the cost of energy as much as boys.

11. Wind energy is probably impractical where I live.

12. I think were all becoming too dependent on computers.

13. Only engineers and technicians really have to know anything about computers.

14. It can be fun to design your own invention or system.

15. I would rather work on a car than fool with a computer.

16. It's really sort of scary that we waste so much energy.

17. I don't like learning how to use computers.

18. Atomic energy has relatively few problems and is cheap.

19. I'm concerned that a war will be fought over rights to oil.

20. I like math more now since I see how it solves practical problems.

INTEGRATED ENERGY SYSTEMS

MODULE EVALUATION FORM

DIRECTIONS:

Attached to this instrument is an answer sheet on which you will record your responses. Please print your name, age, gender, the current date, grade level, instructor's name and school name in the areas provided. DO THIS NOW!

Each of the statements below is neither correct nor incorrect. You are simply asked to indicate how strongly you agree or disagree with each statement. On the answer sheet there are five numbers for each item. If you strongly disagree with an item, darken the 1. If you strongly agree, darken the 5. Marking 3would indicate you neither agree nor disagree. You may use any number from 1 to 5. Do not think about your answer too long. You have 10 minutes to complete the instrument. Go ahead.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor	Agree	Strongly Disagree

1. The reading assignments were interesting to read.

2. I had difficulty understanding many of the words in the reading material.

3. We needed more time to do the lab activities.

4. I found the films interesting and would like to have seen more.

5. The teacher did a good job of presenting material in class.

6. I would have liked to spend more time in experimenting with the collector.

7. Many students just "goofed off" and let others do the work.

8. This module should be taught in science and not industrial arts.

9. We should have had a course in computers before taking this module.

10. We wasted some time on unimportant things.

11. I don't think the teacher had gone through the material before we did.

12. I found the heat exchanger section interesting.

13. In comparison to other parts of this course, this was one of the best.

14. The computer interfacing part was the hardest.

15. The mathematics used in this module was fairly easy for me.

16. I liked the assembly of the demonstration unit the best.

17. The tests were too hard.

18. The section on hydraulics was quite good.

19. I learned a lot about power supplies from this module.

20. My interest in computer systems has increased during this module.

21. We should have spent more time in class discussing the energy shortage.

22. The computer games were good ways to teach me some concepts.

23. I found the computer equipment hard to use.

24. The area on solenoids and valves taught me material I didn't know before.

25. Compared to units in my other courses, this was one of the best.

INTRODUCTION TO SOLAR COLLECTORS

The term "solar collector" can best be defined as a RADIANT ENERGY ISOLATION DEVICE. Actually, all surfaces struck by the sun "collect" solar energy. Yet, in most instances, this energy is given up to the surrounding environment without control. The device that we think of as a solar collector isolates, or retains, this energy, which can then be controlled and directed to perform work. This work is usually the heating of either liquid or air.

Solar heating is not a new idea. Solar water heaters have been used for many years in isolated parts of Austrialia, Israel, Japan, and elsewhere. As early as 400 B.C., Xenophon, a Greek historian, wrote that the south sides of houses should be built higher to get the winter sun. Archimedes is thought to have set fire to the sails of ships in battle by concentrating the sun's rays.

In modern times, decreasing supplies of fossil fuels place a great importance on the use of the sun's huge supply of energy.

The sun creates its tremendous energy by nuclear fusion which converts 4.2 tons of matter into energy each second. This energy is released in the form of high-frequency electromagnetic radiation. The radiation comes in waves, the more energetic the radiation, the shorter its wavelength. RADIATION COMES FROM THE SUN IN ALL WAVELENGTHS from long radio waves to short X rays. About half of the radiation from the sun is in wavelengths longer than those visible to our eyes. These are "below red" or infrared waves. It is this infrared energy that we experience in the form of heat.

The most important principle of these different wavelengths of light has to do with the way they can be trapped by passing them through a transparent material, and onto a surface underneath. The surface underneath will absorb a portion of the visible wavelengths, depending on its color, and reflect back primarily infrared, or long wavelengths. Most transparent materials, such as glass, will not allow these longer wavelengths to pass back through to escape. This effectively traps the energy underneath the transparent surface. This process of trapping heat is called the GREENHOUSE EFFECT. A good example of this is how unbearably hot an enclosed car can get on a sunny day.

When speaking of solar collectors, the transparent material is usually glass or plastic. This is called the glazing. The surface underneath, which is generally black to absorb the maximum amount of the visible wavelengths of energy, is called the absorber. Of course ,the absorber is usually enclosed in an insulated box, with the glazing over one side, to prevent the escape of the collected energy. Therefore, a simple flat plate collector would need nothing more than a clear GLAZING, a flat ABSORBER, and some form of an ENCLOSURE to trap a good portion of the sun's radiant energy striking it. The trick now is to take this energy, which is now in the form of heat, and transfer it for use. To do this we need to understand the principles of heat transfer.

Assuming that our absorber plate is now heated by the solar radiation, we need to take the heat from the absorber plate and TRANSFER it to where we want to use it. There are three ways that heat is transferred from one place to another. However, to understand them you must first realize that a material always seeks to achieve a temperature equilibrium, or balance, with its surroundings. The three ways it can achieve this is by the principles of conduction, convection, or radiation.

First, which we have already mentioned, is RADIATION. All materials are constantly radiating thermal radiation in all directions because of vibrational movement of their molecules, which we physically sense as heat. The amount heat radiated is determined by several things, the first being simply the temperature of the radiating surface. The amount of radiated energy is also affected by the material's efficiency of radiation. We rate this as a surface's EMISSIVITY. Most common materials are pretty good emitters of thermal radiation. The emittance (E) of a material is an indication of this ability. Many building materials, for example, have an emissivities of 0.9 which means that they radiate 90% of the thermal energy theoretically possible at a given temperature. In general, smooth or shiny surfaces have lower emissivity than rough or dull surfaces.

Second, heat will be transferred by materials within themselves, or to anything else that they are physically touching. This is called CONDUCTION. Conduction is the process by which heat is transferred between molecules within a substance, or between two substanced in direct physical contact with one another. Any subtance's ability to do this is called its conductivity (K). Materials vary greatly in conductivity. For instance, touch a metal portion of your desk, it will feel colder than if you touch a wooden portion of the same desk. This is because the metal has a higher K and therefore transfers the heat from your hand more quickly than the wood which has a lower K.

Third, heat will be transferred from a

material's surface to the molecules of an adjacent fluid (by fluid we mean either liquid or air). This is called CONVECTION. Remembering that heat always moves from warm to cool, convection can move heat from a solid to a liquid, or the other way around. A very important aspect of convection is the fact that if the fluid is pumped or blown across the non-liquid surface, the heat transfer will be increased.

Now let's review where these transfers of heat would take place in a simple, flat plate solar collector. RADIATIANT energy comes from the sun in the forms of ultraviolet, visible, and infared waves. The glazing of our solar collector passes virtually all visible radiation, allowing it to strike the absorber plate. Radiant heat transfer warms the absorber plate. The absorber plate absorbes a portion of the radiation, and reflects the rest back towards the glazing. Since the reflected radiation is now basically long wave, the glazing does not allow it to escape, but contains it by reflecting it back again to the absorber plate. This "greenhouse" effect further heats the absorber plate.

Since the sun does not always strike all portions of the absorber plate evenly, CONDUCTION now takes place within the absorber plate. This will even out the amount of heat throughout the entire absorber and also transfer the heat energy to anything else, such as water tubes, that are in direct physical contact with the plate.

Should we now pass a fluid (either air or liquid), through the enclosure that supports the glazing and absorber plate, CONVECTION will take place. This will transfer the heat energy to the fluid, heating it. We can now either use this heated fluid directly, or use convection to transfer the heat yet another timefor other possible uses.

This is the basic energy conversions that take place in a solar collector. However, each of the basic parts, though simple in nature, can be optimized by design so that a maximum amount of energy is captured and converted to the desired form. You may someday wish to design your own collector, so let's look at some of materials used to make specific parts. Each material chosen has advantages and disadvantages, and as in anything else, the best materials are not often the cheapest.

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SOLAR PANEL GLAZINGS

The main thing that we want a glazing to do is to TRANSMIT solar radiation. Whenever solar radiation penetrates a material, it will either be transmitted or absorbed. If a material transmits most of the visible radiation it is called TRANSPARENT. Some materials can be equally transmissive, but will scatter or somewhat deflect the radiation. This would also be good for a glazing material. These materials would be called TRANSLUCENT. All materials reflect back some of the radiant energy, as well as absorb some. For instance, clear glass will pass about 85% of the solar energy striking its surface. Two layers would pass about 75%, so glass would be a pretty good glazing.

No glazing will pass all of the radiant energy hitting it because of reflection and absorption. An example of reflection is when you are temporarily blinded by the sun coming off an automobile windshield. A simple test for reflectivity could be performed by using a light meter or other device aimed in the direction of the glazing while light is striking it from that same side. Any increase in reading over that of the normal background light would be reflected light.

Absorbed light will show up as an increase in temperature of the glazing itself. This temperature increase could be measured and, taking into account the specific heat of the material, the energy absorption calculated. It is very important to remember that reflectivity is extremely critical in terms of the angle the light is striking the glazing. Of course, the ideal angle of light transmission to the glazing is 90 degrees. 15 degrees either way from this has a rather small effect, however, the amount of energy transmitted falls off sharply if the angle approaches 50 degrees in either direction. This is one reason a solar collector's orientation to sun is so important.

Every type of glazing has advantages and disadvantages. GLASS has a relatively low price, good transmission, good rigidity, and attractive appearance. Unfortunately, it is rather fragile and has very low insulative value (remember we want to retain as much heat inside the enclosure as possible, thus we want it insulated from the outside environment). For these reasons, glass is not used in all collectors, and other glazings have been developed.

Almost all other glazings fall into the category of PLASTICS. Many types of plastics have been used including fiberglass, polyethylene, acrylics, and others. Their advantages include, light weight, good transmission, strength, toughness, workability, and relatively good insulative values. Two main disadvantages are price and deterioration by ultra violet light. However, due to rapid progress in the plastics industry, plastics may some day be used for most glazings.

Where there is a great difference in the temperatures between the outside and the inside of the collector glazing, there may be an overall gain in efficiency if two glazing layers are used. However efficiency may actually be lost if there is not a great difference in temperature. For instance, air collectors are usually just as efficient with either one or two glazings at approximately 20 degrees. Outside temperatures lower than this would show a slight gain in efficiency with the double glazing.

ABSORBER PLATES

There are two things that an absorber plate must do. First, it must collect a maximum amount of radiant energy. Second, it must transfer a maximum amount of this energy to the fluid (either air or liquid). Therefore, we are once again concerned with REFLECTIVITY and ABSORBTIVITY. The goal with absorbers is an absolute minimum of reflectivity, and a maximum of absorption. Because of this, the surface coating is more important than the material that is used to support the coating. The absorber must also be able to withstand the temperatures developed by its absorption of the radiant energy. For this reason, most absorber plates are made from coated metal.

The type of metal used for the absorber is important in two respects, physical STRENGTH, and THERMAL MASS. Of course, price is also a major consideration, so this limits selection to commonly available metals.

ALUMINUM is widely used because of its advantages of low price, low thermal mass, and excellent thermal conductivity. Its disadvantages include its inability to accept some types of coatings, difficulty in joining (it does not solder well, for instance), considerable expansion and contraction as it is heated and cooled, and possible dissimilar metal corrosion when joined with other metals, such as copper pipes.

STEEL is also popular because of its even lower price, strength, thermal dimensional stabiliy, weldability, and acceptabitity of most coatings. However, its thermal mass is quite high (it takes a lot of heat to change temperatures), it is rather heavy, and corrodes unless coated.

COPPER is perhaps the best of the commonly available absorber materials. Its advantages include outstanding thermal conductivity, acceptance of almost all commonly used coatings (including black chrome, which we will talk about later), easy soldering, and lack of dissimilar metal corrosion when joined with often-used copper pipe in liquid systems. Unfortunately, it is rather expensive to electroplate, is rather expensive itself, and is not as strong as some of the other materials.

As I stated before, the coatings on the material are more important than the material itself. Very seldom is the material used without a coating, if for no other reason than most metals are shiny and therefore have a great deal of reflectivity. The coatings can range from very simple to very complex, but all are to decrease reflectivity and increase absorbtivity. In general, coatings are black to absorb the maximum amount of light. Dark colors absorb most of the wavelengths of visible light, lighter colors selectively reflect some wavelengths. This, of course, decreases the amount of radiant energy absorbed. Also, coatings are generally dull, to reduce further the amount of reflected radiant energy.

PAINT, most often flat black, is the most economical approach. The disadvantage is that it is also somewhat of an insulator, limiting its effectiveness. Paints in general have the problem of ultravoilet light degeneration, oxidation, and therefore limited life.

ELECTROPLATED COATINGS, especially black chrome, are considerably more expensive. The advantages of black chrome, and most electroplated coatings, include extremely good thermal conductivity, resistance to ultraviolet light degeneration, minimal oxidation, and exceptional durability. While black chrome is shiny, therfore having some losses to reflection, its increased conductivity more than offsets it. This makes black chrome perhaps the best coating available with current technology. This is especially true when it is applied to copper, which also has very high thermal conductivity.

ENCLOSURES

The best definition of an enclosure is any device that contains, on at least one surface of it, a glazing (or anything else that allows radiant energy to pass). Notice that we have not said that it must have certain dimensions, or even have been built specifically to collect solar energy. Therefore, the enclosure may be a car, a wall, or anything else that is reasonably air tight. Obviously, an enclosure design can be improved by following proven design practices.

One very desirable characteristic of an enclosure would be to have one surface as large as possible for the maximum size of glazing. Secondly, the volume of the enclosure should be as small as possible. This is important because then there is a minimal outside surface area producing a conductive loss. Finally, the enclosure should be well INSULATED. Insulation, which is a material with low thermal conductivity, prevents the heat energy inside the enclosure from radiating outside by thermal conduction. For most applications, all sides of an enclosure should be insulated to at least R 12. It is important to remember that the glazing, while it must transmit a maximum amount of solar radiation, should also be as insulative as possible. This is often partially accomplished by using double glazings with an air space in between them. As we have stated before, this depends on how low the outside temperature is relative to the inside temperature.

The most important consideration for any enclosure is its ORIENTATION TO THE SUN. The glazing simply must be aiming towards the sun to collect any useable amount of solar energy. How closely it must be aimed is determined by the reflectivity of the glazing at different angles of transmittance, as well as the nature of radiant energy itself.

The greatest amount of energy will strike an object which is exactly PERPENDICULAR to its path.

Imagine radiant energy as drops of rain during a light shower. If you were to stand in a light rain with a piece of glazing material, and hold the material vertical to the ground (which is parallel to the paths of the drops), no raindrops would strike it. If you were to now rotate the glazing parallel to the ground (perpendicular to the paths of the raindrops), many more raindrops would strike it. If you were to do the same thing with an opaque material on a sunny day, you would find the opaque material would cast the LARGEST SHADOW by holding it perpendicular to the angle of the sun. THE LARGER THE SHADOW, the MORE SOLAR ENERGY STRIKING IT.

In Iowa, which is about 40 to 43 degrees North Latitude, all solar collection devices should face south. As a matter of fact, all places on earth north of the equator would have solar devices facing south. However, the angle of the collector to the ground (from here on referred to as TILT), will vary according to the lattitude of the locality where the device is placed. If a collector is secured at any one angle, it will only be at its optimum performance for about one hour of one day during an entire year. This is because the sun sweeps across the south half of the sky from east to west daily, also sweeping higher in the summer and lower in the winter. Due south will generally optimize a fixed collector for the daily sweep of the sun, but the higher or lower sweep due to seasonal changes must take into account the use of the collector and the lattitude of the locallity where it is used.

If a collector is being used year round, the tilt is usually optimized at the LATTITUDE + 10 degrees. However, if the unit is utilized for winter heating only, reflection from snow cover can add about 10% to the radiant energy if the unit is mounted VERTICAL. There is some arguement as to which tilt is best for a given situation. One thing is for sure, to optimize output, the collector should not be fixed in one position, but trace the path of the sun.

As we have discussed before. The glazing will REFLECT more energy back to the atmosphere if it is not PERPENDICULAR to the sun. This becomes an important factor if the angle of radiant energy strikes the glazing at an angle of more than 50 degrees from perpendicular. Generally speaking, a solar collection device can be off about 15 degrees before efficiency is seriously affected.

IN SUMMARY

Solar collection units usually consist of three major parts, a GLAZING which allows radiant energy to pass through and strike an ABSORBER which changes primarily visible light into longer wavelength heat energy. Both of these components are held in position by an ENCLOSURE which also insulates the heat from the outside environment.

The ORIENTATION of a solar collector to the sun is critical, and must be kept within 15 degrees for efficient operation.

REFERENCES FOR SOLAR COLLECTORS

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SOLAR HEATING DESIGN, William Beckman, John Wiley & Sons, 1977.

BUILD YOUR OWN MINIMUM COST SOLAR HEATING SYSTEM, Robert P. Haviland, Tab Books Inc., 1982.

ADDING SOLAR HEAT TO YOUR HOME, Robert W. Adams, Tab Books Inc., 1979.

PASSIVE SOLAR INFORMATION MANUAL, Iowa Energy Policy Council Solar Office, Capitol Complex, Des Moines, Iowa, 50319.

SOLAR SELF-CHECK QUESTIONS

1) Define the term "solar collector"?

2) How does a solar collector differ in function from a tin can lying in the sun?

3) What are two fluids commonly used to transfer heat energy away from solar collectors?

4) Besides wavelengths of energy in the visible light spectrum, what are two other wavelengths of light transmitted from the sun?

5) What is the use of the "Greenhouse Effect" in solar collectors?

6) Should a collector glazing have high reflectivity? Why or why not?

7) What are the three forms of heat transmission between matter?

8) How is convection different from conduction?

9) In a properly designed solar collector, why does the absorber plate heat up more than the glazing?

10) Name one advantage that plastic has as a glazing that glass does not.

11) What is more important in a glazing, transmissivity or reflectivity?

12) What determines whether one or two glazings, with an airspace in between, are used on a solar collector?

13) Name three of the most commonly used materials for absorber plates.

14) Why are coatings frequently used on absorber plates?

15) Name one major disadvantage of paint as an absorber coating.

16) Why do solar collectors use an air-tight enclosures?

17) Why is solar orientation so important to the efficiency of the unit?

18) How does the sun's path in the sky vary as the seasons change?

19) Which collector would work most efficiently, a fixed unit or one that tracks the sun?

20) Why is it important to insulate a solar enclosure?

HYDRAULIC SYSTEMS

BASIC FLUID POWER

Hydraulic is the term that comes from the Greek word "hydraulis" meaning water pipe or water powered. Hydraulics is much more than an energy or power system, therefore the term fluid power will be used to cover the principles of energy or power transmission.

Fluid power is the transmission and control of energy by means of a pressurized fluid. Fluid power has been used for thousands of years in an open fluid power system. These open fluid systems used the force of moving water from a stream or river to turn large water wheels, which in turn provided energy to do work.

Open fluid power systems use a large volume of fluid at relatively low pressure to transmit energy to the mechanical device being operated. These open fluid power sustems were very useful and practical, but were very limited in the types of operations that could be performed. This system is of a permanent nature and is not easily moved from place to place.

Modern machining techniques have made it possible to develop a closed fluid power system. The closed fluid power system uses a low volume of fluid at very high pressures. This system is a compact system that can transmit energy to almost any location through hydraulic lines.

Some of the advantages of a closed fluid power system are: (1) ease and accuracy of control, (2) tremendous force or speed multiplication capabilities, (3) efficient and economical to use, and (4) few moving parts provide for greater safety and less maintainance. These factors coupled with the wide variety of sizes and applications of fluid power make the closed fluid power system increasingly popular with industry today. Closed fluid power systems may be as diversified as a small dentist's drill operating at 100,000 revolutions per minute or as large as a car crusher operating at 100 ton capacity.

The closed fluid power system has 4 basic components: the prime mover, the pump, the control valves, and the actuator (device that changes fluid power into mechanical power).

The prime mover of a fluid power system is the device that provides power or drive to the hydraulic pump. In a simple system such as a hydraulic jack, the person would be the prime mover.

However, in the more complex systems, the prime is usually an electric motor or an internal combustion engine (gas or deisel). At present technology levels these two sources of power are very dependable, economical, and readily available.

The pump of a fluid power system is used to create fluid flow. The pump may be of several different types depending on the primary need of the system. Thetwo main types of fluid flow requirements are (1) high volume at low pressure and (2) low volume at high pressure. Hydraulic pumps are designed to produce a certain fluid flow characteristic to meet the demands each system needs.

Another component of the fluid power system is the valve. A valve is a mechanical device with internal moving parts that connect and disconnect fluid passages within the valve. The valves of fluid power systems are used to control direction, pressure, and volume of fluid flow. These devices are essential in controlling all fluid power operated machinery. The valves may be operated manually or from a distance by remote control devices. Valves provide an easy and convenient way to control fluid flow.

The actuator of a fluid power system is the component that changes fluid power into mechanical power. The actuator of a closed fluid power system is usually a hydraulic motor, used for creating rotary motion, or a hydrauliccylinder, used to create straight line or linear motion. These actuators provide the the mechanical advantage to do work.

All fluid power sysems have associated parts of: (1) hydraulic lines or passageways to carry fluid flow, (2) a reservoir to return fluid for reuse and as an aide in cooling, and (3) a filter to remove impurities (dirt, moisture, and metal fillings) from the system. All of these parts are needed to complete a closed fluid power system. These fluid power systems provide the directional diversity and the force or speed amplification needed to do the major portion of the once manual tasks done in industry today.

As in any power system, there is a certain amount of danger associated with the operation of the fluid power system. The mechanical linkage between the prime mover andthe hydraulic pump requires shaft movement that could entangle some unsuspecting person.

Fluid power systems operate at very high pressures that could cause a dangerous erruption of lines or components if abused or improperly maintained.

The high pressures involved in a fluid power system also produce tremendous amounts of heat. Heat always produces a danger of burns or fire.

But as usual, being alert and knowledgeable provides the best defense against injury.

FLUIDS

Fluids that are used in fluid power systems incorporate both liquids and gases as mediums for transmitting power. Oil, with special flow characteristics and special additives, provide the majority of the liquid transmission mediums used today.

Gases used in fluid power systems are most generally confined to air and are included under the subsection of pneumatics.

Fluids in the hydraulic system serve several functions but are used primarily to transmit energy.

Apart from energy transmission, the fluid must be able to lubricate the system, assist in sealing the system from internal and external leaks, and to transport heat to a cooling station. The fluid must have a viscosity index that provides workability in cold temperatures as well as hot termperatures. These characteristics of fluid are made possible by special additives. Common additives in the hydraulic fluid are:

1. Viscosity index improver
2. Anti-war additives
3. Anti-oxidation compounds
4. Corrosion inhibitors
5. Anti-foam additives

When working with hydraulic fluids, remember these safety rules:

1. Allow the system to cool prior

to working on it.
Operating temperatures may be in the range of 150 degrees farenheit to 225 degrees farenheit. These temperatures can cause severe burns.

2. Avoid contact between your skin or eyes and the fluid.
Some hydraulic fluids are very caustic.

3. Remove filler caps slowly to relieve any trapped pressure.
Immediate release may cause fluid to spray into your eyes.

4. Many of the hydraulic fluids are flammable. Prevent contact with excessive heat or open flames.

FILTERS

The hydraulic fluid is the life blood of a hydraulic system, but responsibilities of the fluid to transmit energy, lubricate, transport heat, and to seal the system from leaks is greatly impaired if the fluid is contaminated. In order to assume the system is protected from harmful contaminants, a filter is included as an integral part of the fluid power system.

The basic type of filters are (a) surface filters (which have a single surface that catches and removes dirt particles larger than the holes in the filter) and (b) depth filters (which use a large volume of filter material to trap particles as the oil passes through).

Filters are placed within the fluid flow circuit to provide full flow filtration or partial flow filtration. Factors used in specifying a particular filter are:

1. The degree of filtration desired, that is, the minimum size of the

particle to be trapped.

2. The flow rate (volum of fluid going through the system in a specified time.
3. Pressure drop created by use of the filter.
4. Dirt capacity, that is, the volume of debris removed before replacement of the filter is required.
5. System pressure required for filter usage.
6. Operating temperature range requirements.

HYDRAULIC PUMPS

Hydraulic pumps convert the mechanical power transmitted by the prime mover into working fluid power. Most hydraulic pumps in industry today are positive displacement pumps. Positive displacement pumps have the fluid inlet sealed from the fluid outlet; this will deliver fluid any time the inlet is kept supplied and the pump is driven. The positive displacement pumps consist of three main types; (1) gear pump, (2) vane pump, (3) piston pump.

The gear pump basically consists of a housing with inlet and outlet ports, and a pumping mechanism made up of two gears. One gear, the drive gear, is attached to a shaft which is connected to a prime mover. The other gear is the driven gear. The gear pump uses the meshing and unmeshing of the gear teeth to increase and decrease the volume within the housing. At the inlet, where the gear teeth unmesh (increasing volume), fluid enters the housing. The fluid is then trapped between the gear teeth and housing, and carried to the other side of the housing.

At this point, the gear teeth mesh (decreasing the volume) and force the fluid out of the pump housing and into thesystem.

Vane pumps generate a pumping action by causing vanes (flat surfaces radiating from a center axis) to track along the inside of a ring. The rotor of a vane pump houses the vanes and it is attached to a shaft which is connected to a prime mover. As the rotor is turned, vanes are thrown out by centrifugal force and track along the stationary ring. As the vanes make contact, a positive seal is formed between the vane tip and the ring.

The rotor is positioned off-center to the ring. As the rotor is turned, an increasing and decreasing volume is formed within the ring.

Since there are no parts in the ring, a port plate is used to seperate incoming fluid from outgoing fluid. The port plate fits over the ring, rotor, and vanes.

The inlet port of the port plate is located where the increasing volume is formed. The port plate's outlet port is located where the decreasing volume is generated. All fluid enters and exits the pumping mechanism through the port plate. (The inlet and outlet ports in the port plate are connected respectively to the inlet and outlet ports in the pump housing.)

Piston pumps consist of a cylinder barrel, pistons with shoes, swashplate, shoeplate, shoeplate bias spring, and port plate.

The pistons are installed in a circular cylinder block. The cylinder block is attached to the pump shaft and rotates with the shaft. The pistions extend out the cylinder block to contact a fixed plate called the swashplate which is installed at an angle and does not rotate. As the pump shaft rotates, the cylinder block and pistons also turn. Since the swash plate is fixed (does not rotate) the pistons are forced in and out of the cylinder. The pump inlet and outlets are positioned so that fluid is drawn into the cylinder bore from the inlet when the piston is retracted and forced out the outlet when the piston is extended.

Hydraulic pumps are relatively trouble free, if a few basic precautions are taken:

1. Prevent contamination of the fluid. Contamination includes not only solid particles, but also impurities of water and air.
2. The incorrect fluid may result in pump failure in a very short time. The fluid must have the correct viscosity properties, temperature range, and additives.
3. Improper operating procedures also reduce pump life. Pumps must operate at recommended speed and pressure.

HYDRAULIC ACTUATORS

A hydraulic cylinder accepts hydraulic pressure and converts it into a straight-line or linear mechanical force. Hydraulic cyclinders basically consist of a cylinder body, a closure at each end, a movable piston and attached to the piston a piston rod, and parts located at each end of the cylinder for fluid inlet and outlet.

Cylinders develop linear motion as a result of hydraulic pressure being applied to the movable piston. The larger the surface area of the piston, the greater the force capabilities of the cylinder. Cylinders may be a single directional or a two directional system.

Hydraulic motors are rotary actuators. The operation of hydraulic motors is almost the exact reverse operation of a hydraulic pump. In the motor operation, pressurized fluid is received at the inlet and creates force on the face of the gear to rotate the motor shaft.

TERMS

1. Hydraulics - The study of fluids in motion or at rest.

2. Fluid Power - Transmission oand control of energy by means of pressurized fluid.

3. Mechanical Advantage - A ratio of force applied to force output.

4. Open Fluid System - Using the gravitation energy of a fluid to do work.

5. Closed Fluid System - Using a fluid under pressure to transmit energy.

6. Prime Mover - A device that provides power or drive to the hydraulic pump.

7. Pump - A device used to create fluid flow.

8. Valves - A device used to control luid flow.

9. Actuator - A device that changes fluid power into mechanical power.

10. Hydraulic lines - A piping system used to convey fluids.

11. Reservoir - A container for holding a supply of fluid.

12. Filter - A device which removes contaminates from a

hydraulic system.

13. Pressure - The force exerted over a surface divided by its area.

14. Line - A tube, pipe, or hose for conducting a fluid.

15. Displacement - The volume of fluid which is transferred from the pump inlet to the outlet during one revolution of the pump.

16. Cavitation - The formation of air bubbles in the inlet of a pump because the inlet does not completely fill with fluid.

17. Aeration - air trapped in the hydraulic fluid.

18. Positive Displacement - A pump whose inlet is sealed from the outlet; will deliver fluid any time the inlet is kept supplied and the pump is driven.

19. Nonpositive Displacement - A pump whose inlet and outlet are hydraulically connected so that the fluid can recirculate in the pump when pressure builds up.

APPENDIX H

MANUFACTURING MODULE

MANUFACTURING MODULE

IOWA HIGH SCHOOL INDUSTRIAL ARTS CURRICULUM PROJECT

MANUFACTURING MODULE ON MATERIALS

TEACHER GUIDE

This module has been prepared to be used in high school industrial arts/technology classes. The content covered can be infused into a wide range of courses but it is closely related to courses in industrial materials.

This and other modules have been prepared as a part of Phase II of the Iowa High School Industrial Arts Project. The project was conceived by the Iowa Industrial Arts Cadre and sponsored by the Iowa Department of Public Instruction.

Those persons involved in the preparation of this module include:

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I. General

A. Rationale

The industrial setting consists of an environment in which materials are processed into a product for consumption. The process of converting materials to a product is generally accomplished within a manufacturing setting. The manufacturing setting incorporates materials, processes, and organization or management for the production of the product. All elements are of equal importance and the process of manufacturing could not continue with the exclusion of any one.

The organization of the concepts of manufacturing into a system perspective using the components of input, process, and output has been accomplished on the diagram on the following page.

The system elements of manufacturing consist of input-organization; process-materials and processes; and output-product. The concepts identified are utilized to deliver the information relative to the systems elements. The diagram also identifies the program size in which each concept and element are recommended for delivery.

The area of manufacturing chosen for delivery in this module is materials. The rationale for this choice is presented below along with the fact that programs of all levels have the need for delivery of this content.

INDUSTRIAL MATERIALS

The history of industrial materials has its beginning with the origination of mankind. Materials were used in the development of tools as well as clothing and shelter. As the number of materials increased, methods of utilization also increased in the name of products. As man's need for additional products grew, so did his desire to seek out and refine materials.

The development of industrial materials and their uses continues at a rate equivalent to the development of technology. New materials are developed at the rate of approximately fifty per day. The majority of the developments are not new materials, but rather alterations or improvements upon existing materials or composites of materials presently available. Examples of new composite materials include boron, which is a graphite-metals composite utilized in sporting goods equipment and fiberglass, which is a plastic-fiber composite.

The process of developing materials or material composites requires the incorporation of a variety of testing and experimental techniques. The testing and experimentation techniques incorporate the use of a number of testing and evaluation devices. The devices, commonly identified as testing equipment, are utilized to generate data for the decision making process relative to new material application.

MANUFACTURING

LEVEL 9 - 12

ORGANIZATION STRUCTURE

	MANUFACTURING			
System Organization:	Input	Process		Output
Concepts	Organization	Materials	Processes	Products
Measurement	S, M, L	S, M, L	S, M, L	S, M, L
Scientific Principles	M, L	S, M, L	S, M, L	
Systems	M, L		S, M, L	
Energy		M, L	M, L	
Materials		S, M, L	S, M, L	
Technology (past, present, future)	L	S, M, L	M, L	S, M, L
Social Psychological Impacts of Technology	L		M, L	
Ecological Effects		S, M, L	M, L	S, M, L
Careers	S, M, L	S, M, L	S, M, L	S, M, L
Safety	S, M, L	S, M, L	S, M, L	S, M, L
Communications Theory	L		S, M, L	S, M, L
Industrial Organization	M, L	M, L	S, M, L	
High Technology	M, L	S, M, L	S, M, L	
Research & Development	S, M, L	S, M, L	S, M, L	S, M, L
Computer Applications	L	S, M, L	S, M, L	

S - Recommended for small size program - Basic program

M - Recommended for medium size program - Intermediate program

L - Recommended for large size program - Total program

Presently, the average secondary school industrial arts program is involved in the study of industrial materials and processes through the study of methods of processing woods, metals, and plastics. The majority of the activities involves processing the materials into a specific product. Presently, there are limited activities involving testing and analysis of industrial materials. This module was, therefore, developed to assist the secondary school industrial arts program in filling the void in understanding industrial materials.

B. Objectives

The following general objectives are put forth for the module. Specific objectives are listed for each days activity.

Upon completion of the module the student will:

- have an understanding of the role of material analysis in the development and improvement of materials.
- be able to operate basic testing devices
- understand industrial material uses
- understand the role of composites in the improvement of industrial materials
- understand the effect of combining materials to improve physical properties
- understand the relationship between scientific principles and material applications
- understand the importance of measurement and quality control in the processing of industrial materials
- understand the basic concepts of mechanical and thermal properties of industrial materials
- understand the career opportunities related to industrial material analysis and development
- be able to identify applications of scientific principles in his/her environment
- utilize the computer in analyzing results from physical tests
- be able to safely operate machines related to the processing of industrial materials
- understand the role of observing, recording, and record keeping in the analyzing of industrial materials

- realize the importance of group activities in the completion of a given task
- understand the role of an industrial seminar in the sharing of technical information
- understand the importance of following procedures in the fabrication of a product

C. Sources of Information

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Stokes, Vernon L. Manufacturing Materials, Charles E. Merrill Publishing Co., Columbus, OH, 1962

Swanson, Robert S. Plastics Technology, McKnight & McKnight Publishing Co., Bloomington, IL, 1965

Tracy, George R. Modern Physical Science, Holt, Rinehart and Winston Publishing Co., New York, NY, 1979

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D. Test Administration and Student Evaluation

In order to evaluate this module, a pre-test/post-test evaluation is used for the students. The pre-test is designed to measure the student's level prior to using this module. The instructor should therefore give the pre-test at the beginning of the first period with no information given other than telling the students that it is a test to find out how much they know about the material before starting this module. Exactly twenty minutes should be allowed for the test with a normal testing atmosphere maintained. The teacher should not assist the students with terms, etc. that may aid them in obtaining the correct answer.

On the last day, the last part of the period should be used for the post-test. Be sure students are given exactly 20 minutes. Other guidlines, as pointed out in the preceeding paragraph, should be followed. Although the pre-test should not be used as an evaluation tool, the post-test can be used for evaluation.

Also, student evaluation should consist of daily observations, grading of daily assignments, grading of the completed student manual, and evaluation of the student seminar. Daily observations would consist of how well the student carries out procedures for fabrication; how safely they conduct themselves in the lab; how well they stay on task; and how well they work in a group. A teacher should give each student individual daily feedback based on their observations.

Daily assignments are encouraged by the use of a game. The complete description is included along with evaluation suggestions. Each student's standing at the conclusion of the game should provide an easy method of grading. Time is allotted each day that assignments are given for explanation, as well as time the following day for collecting them and playing the game. Consideration was given to time, relevance, and complexity of assignments so that, hopefully, everyone would use them.

The student manual should be given to the student the first day, stressing the importance of keeping it neat and current. Students should know that at the end of the module, it will be turned in for evaluation. At appropriate times (lectures, recording test data, etc.) the pages that are to be filled in should be noted. All pages in the manual are designed to be used to assist in student participation.

A student seminar is conducted on the last day to provide a structure for students to report their results. Not only will this allow the students to become aware of the need for industry to use seminars for sharing information and reaching conclusions, but it will provide the instructor with another good evaluation tool. By encouraging students to report, compare, and discuss results, the instructor can evaluate their problem solving, analysis, and synthesis skills. One can observe if they are involved and thinking, if they are silently listening, if they are spaced out, or if they are disruptive. The same observations hold for the groups' presentation - are they an active or passive participant.

E. Placement Within Existing Curriculum

This module is designed as a beginning level unit for high school students. It can fit in either woods, metals, or general industrial arts. Module content is flexible in placement both course wise and time wise. The module has a dual structure in that both metals and woods-plastics are outlined so that the instructor may select the material that best fits his course. Hopefully, this module can stimulate follow-up activities by the students such as a fiberglass project or researching and using other materials tests. Maximum consideration was given to the utilization of existing facilities and minimal dollar cost for implementation of the module.

F. Master Lists of Equipment, Tools, and Supplies

Tools

1/4" plywood
5 oz. paper cups
butcher paper
polyester resin with
  catalyst
scissors
square
fiberglass cloth
file
acetone
stir sticks
wax paper
steel rule
paper towel
saws
awl
power sander
Universal testing device
  (1/4" plate & 1/2" threaded rod)
  (2-4" vice jaws & 1/2 ID pipe)
Bending & shear jigs
2 straight jaw vice grips
1/4 ID acrylic tubing
3/16 drill rod
1 1/2 or 2 ton hydraulic jack w/2000# pressure gauge
Assorted types of sheet metal
  (ferrous & non-ferrous)
Assorted types of metal rod
  (ferrous & non-ferrous)
3/16 D metal ball
O-A torch
Propane torch
Ring stand with clamp
Metal shear
Tin snips
Crucible
Pyrometer
Stop watch
Computer system
Fire brick

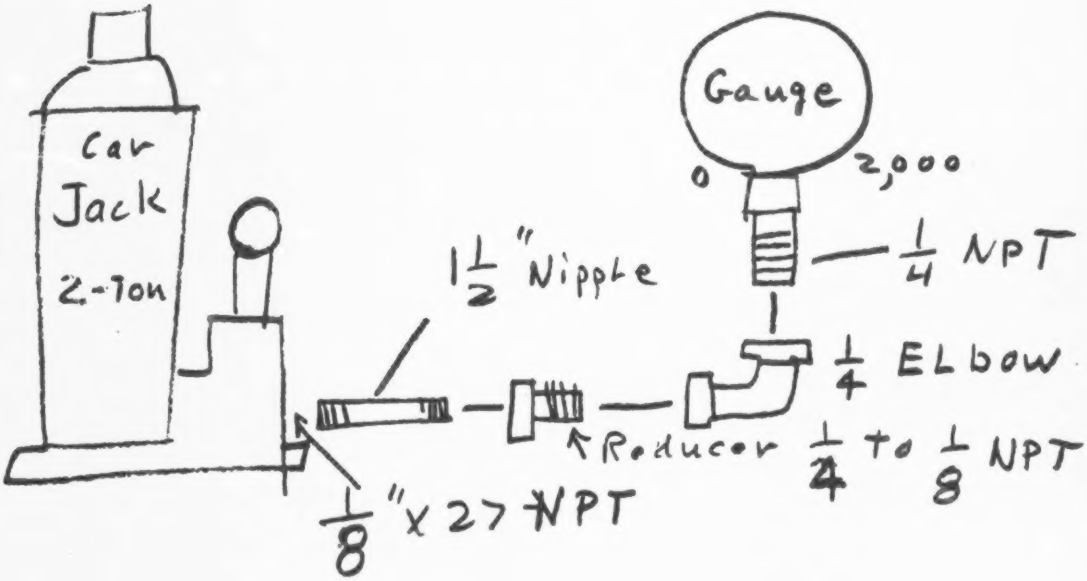
A.V. Equipment

Overhead projector
16mm film projector
Video cassette recorder

A.V. Aids

Transparencies
Samples of gas
16mm film
Transparency pens

Jack assemble and fitting of gauge



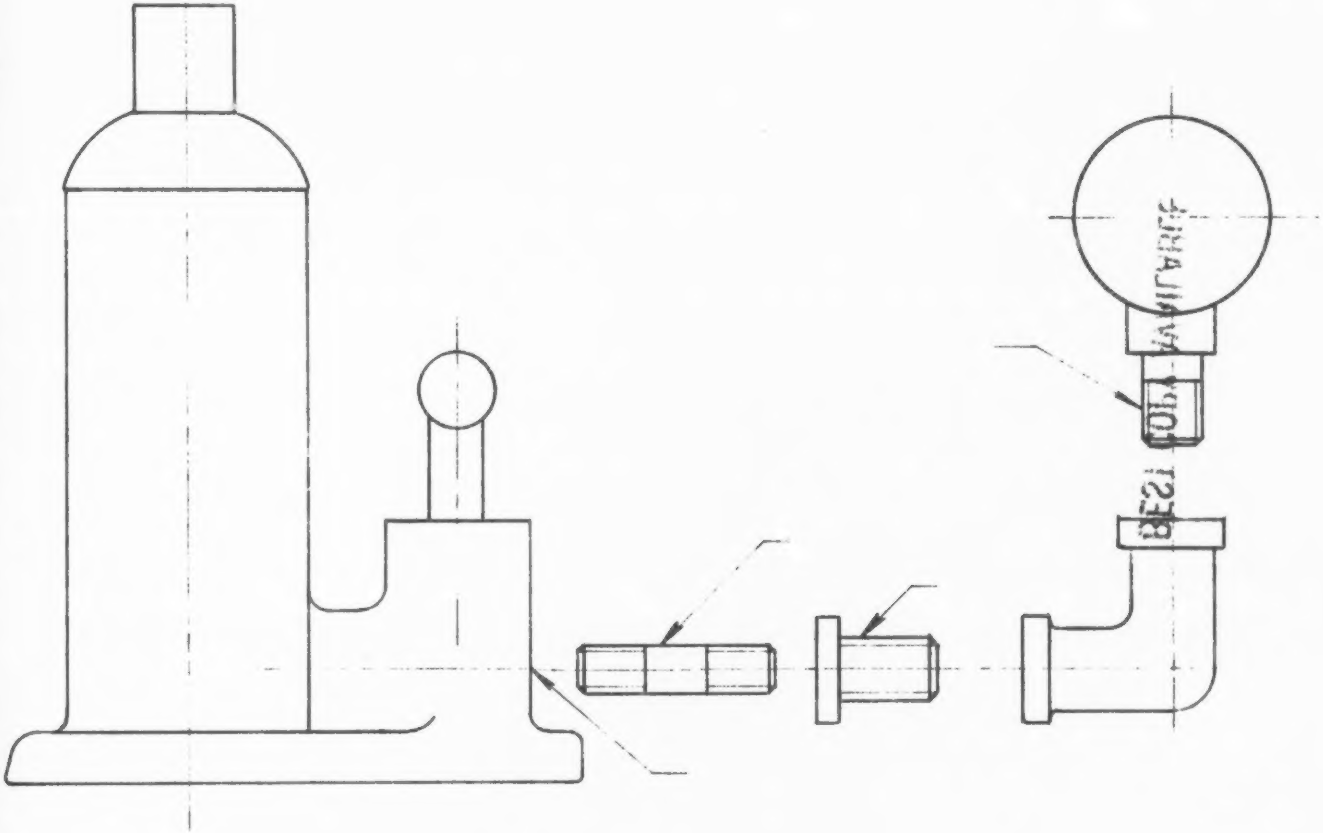
Car Jack — Local Auto Parts dealer or Hardware Store

General Service Gauge — Marshalltown Insturament Series 78K or through Local - Hardware Store

0 - 2000 PSI

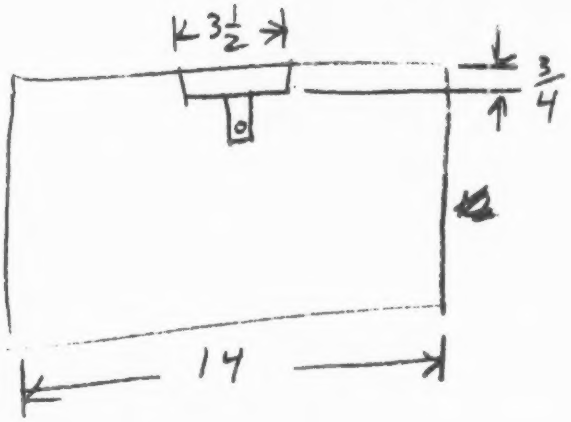
G19751 Price $\boxed{34.05}$

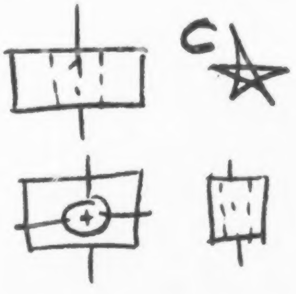
Bulletin #28-6.5



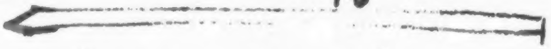
Hardness and Impact tester

(Plywoord or Solid stock)

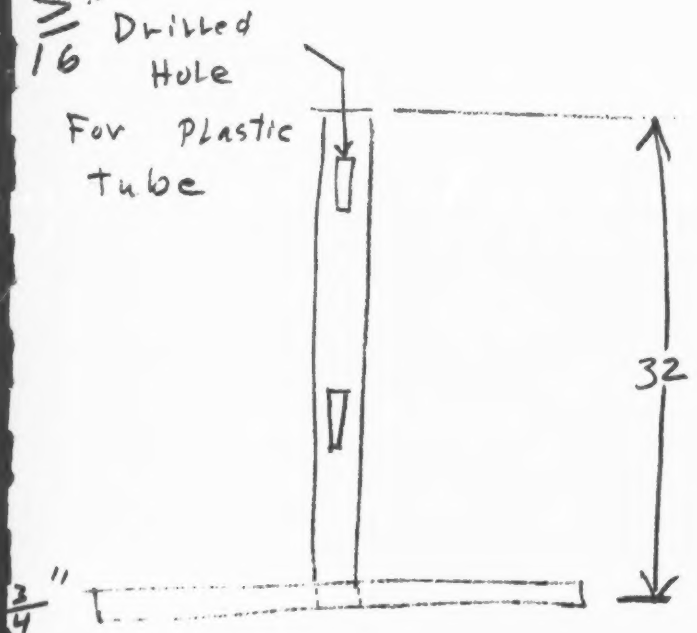


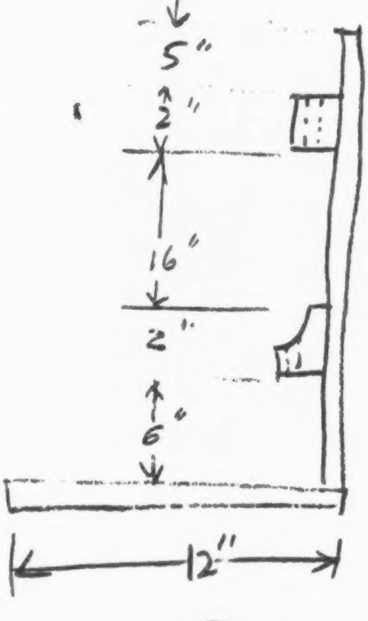


(D) Drill Rod 3/16" x 20"



Drop Pin for test stand





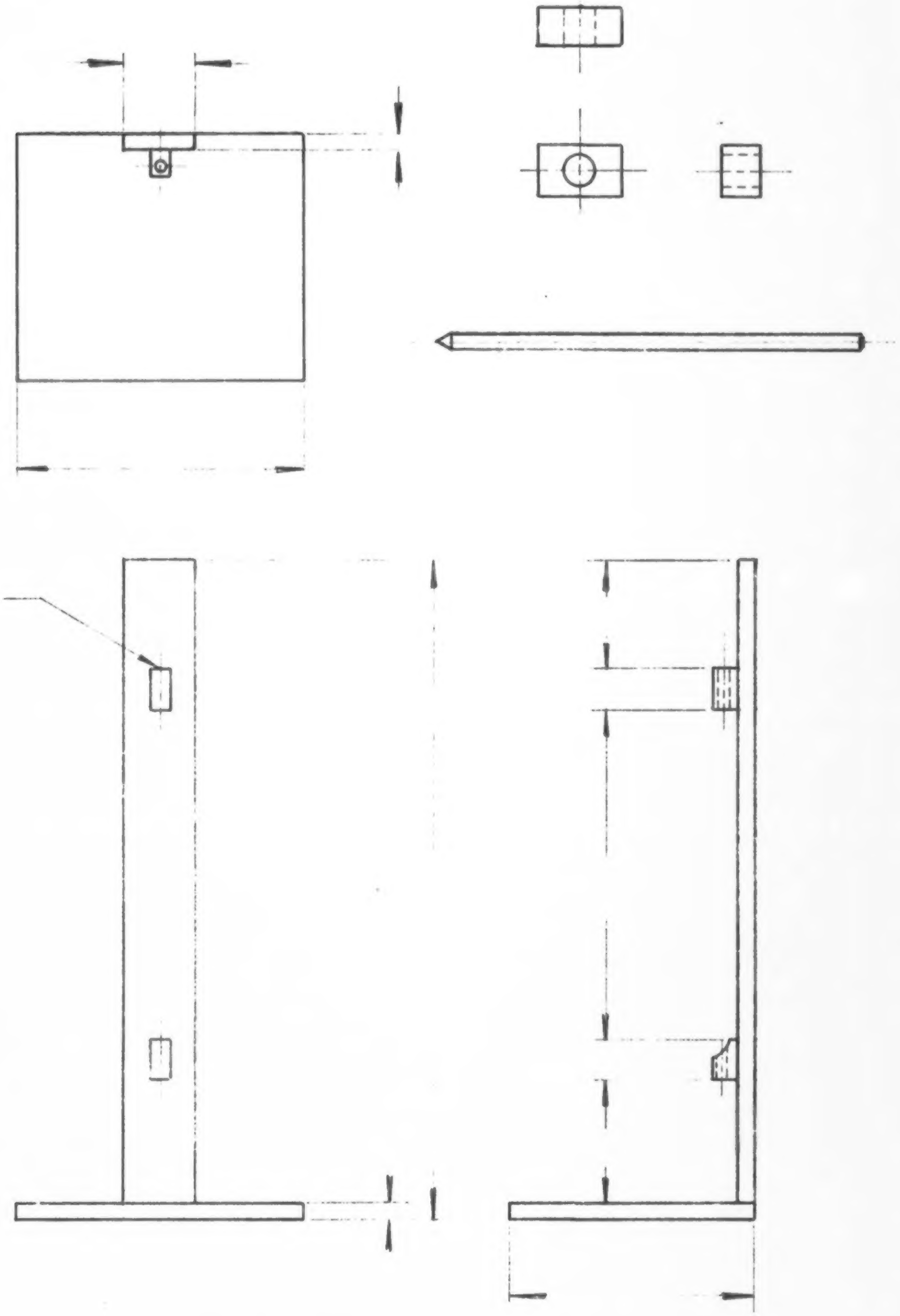
(E) 3/16 O Round Steel Ball

☆

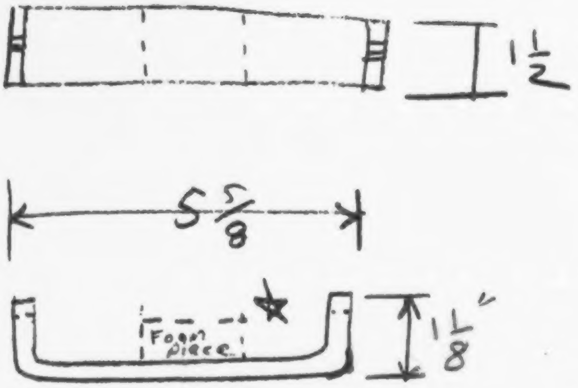
(A) Tube to fit in Holes
Plastic 1/4" ID x 36"
Van Horn Plastic
Nasco

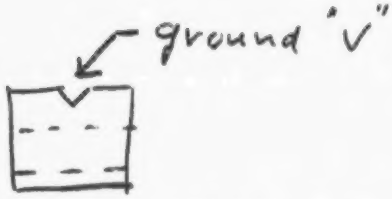
(B) Wood for Test. equipment
School Shop

(C) 1 1/2 x 2" Block
with 3/8" Hole
Drill through
for test stand



Bend Test Fixture



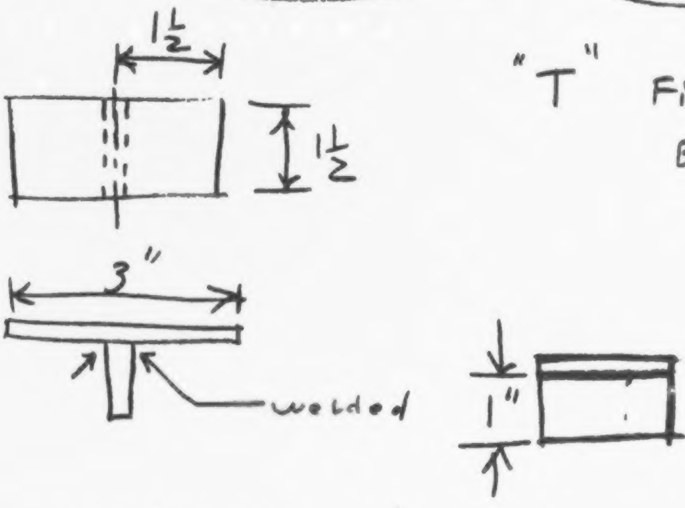


Material $\frac{1}{8} \times 1\frac{1}{2}$ Flat" Metal Stock

★ Foam Rubber Block To Be Place on Fixture $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$ thick

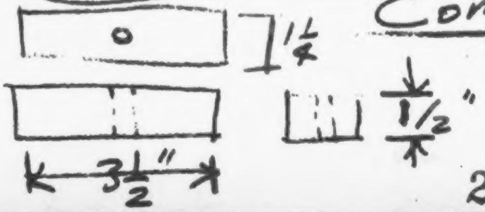
---

"T" Fixture for Bend Tester



Material $\frac{1}{8} \times 1\frac{1}{2}$ Flat Metal Stock

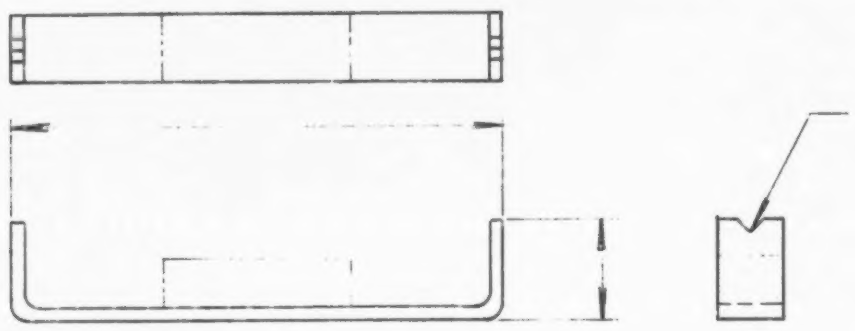
Compression Test Aids

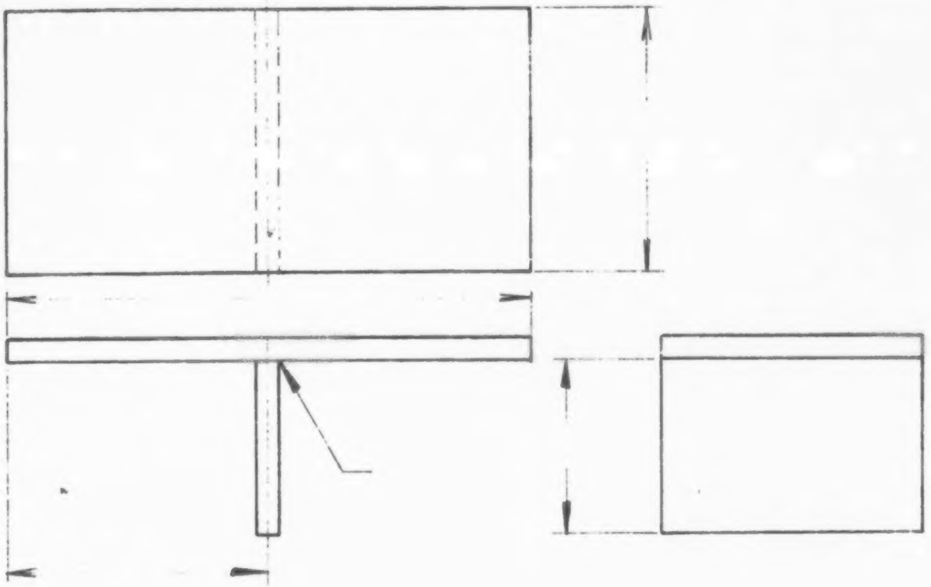


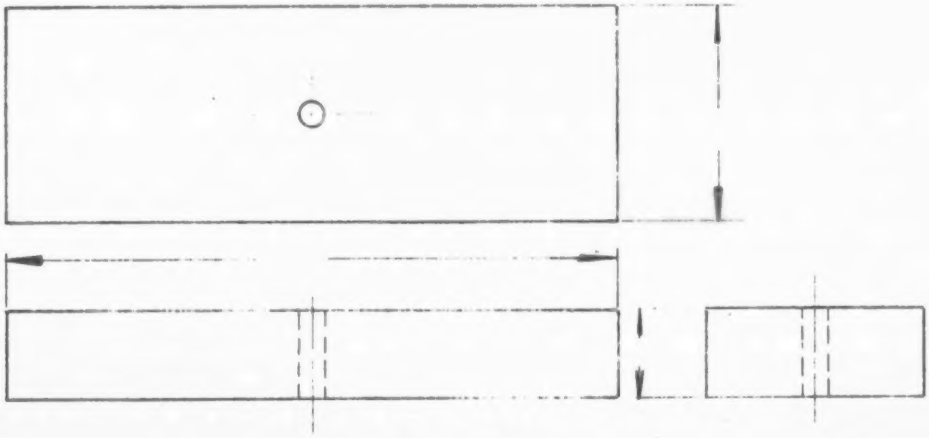
Hole Size $\frac{1}{8}$"

Support Guide Block

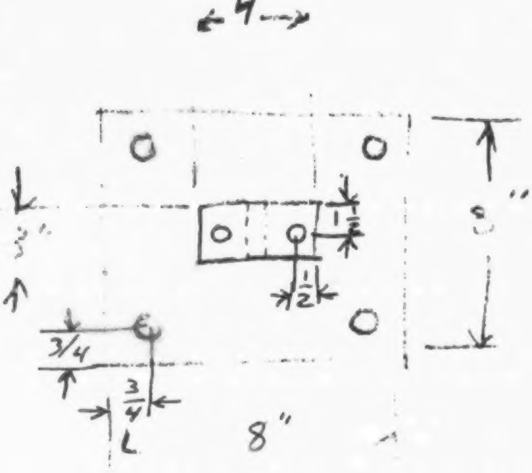
286 for Compression



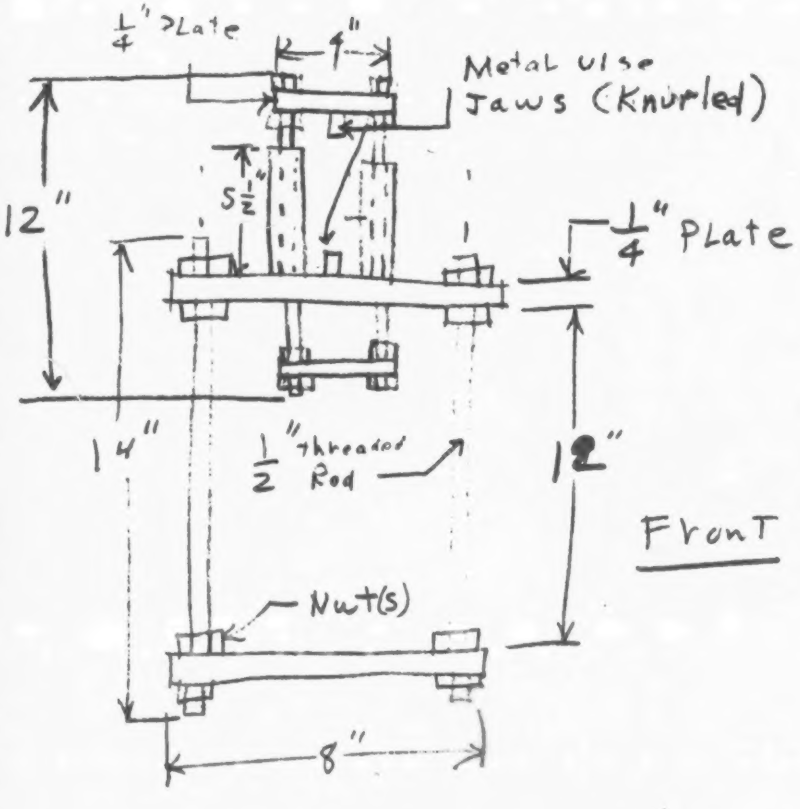




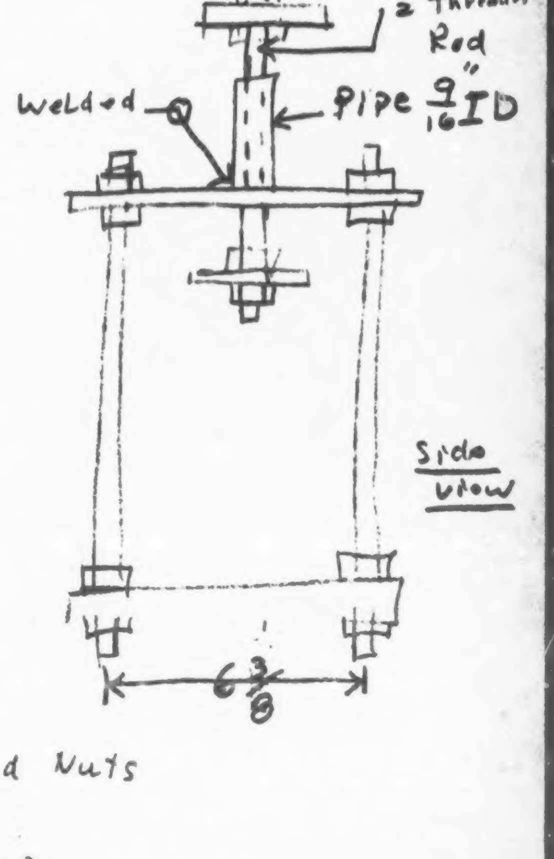
Universal tester



TOP



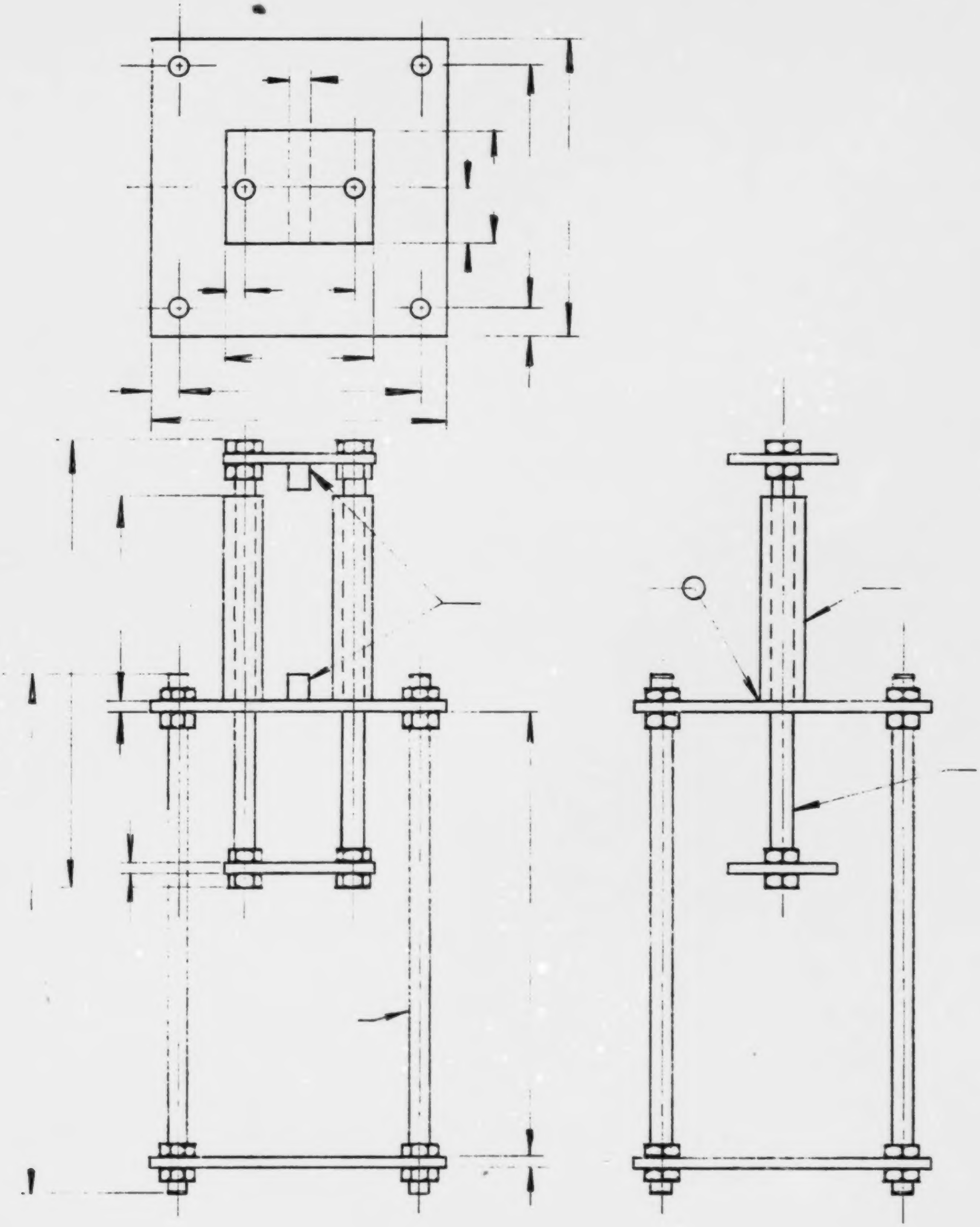
Front



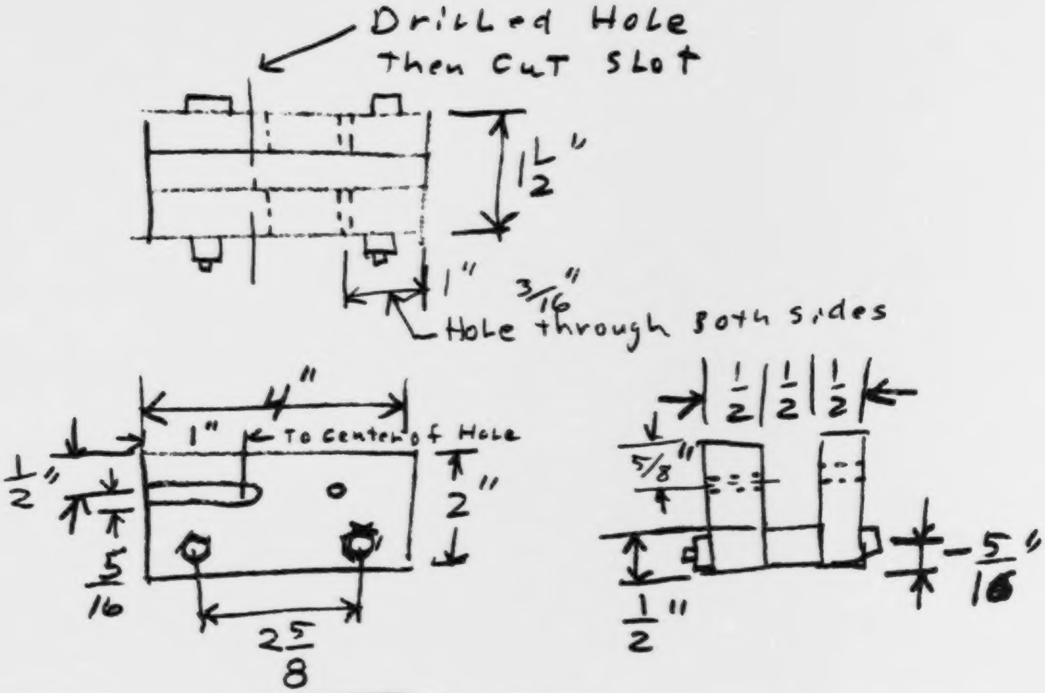
Side view

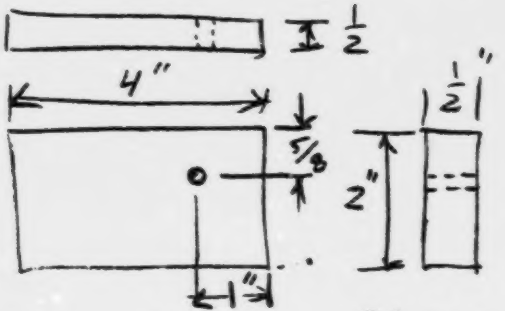
Threaded Rod 1/2" Dia and Nuts
Hardware Store

Steel Plate School Shop
Pipe Welding Shop
Steel Supply

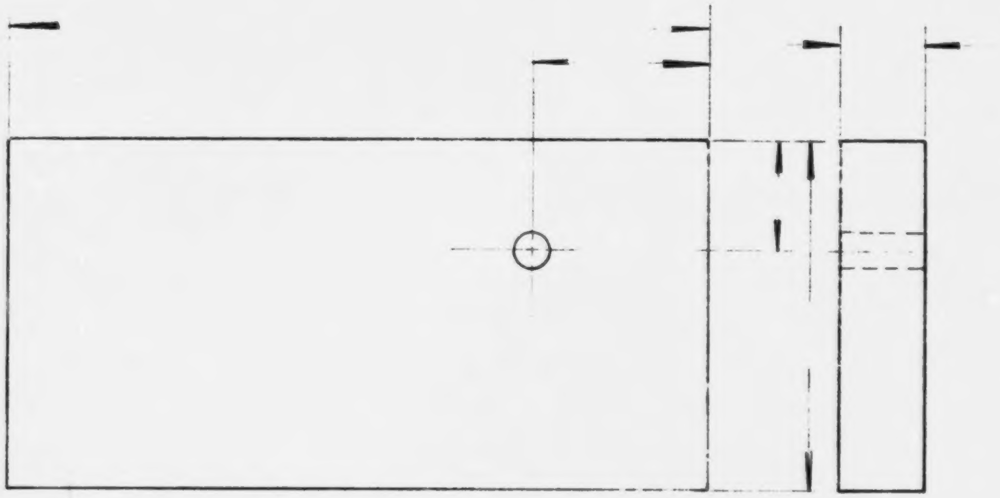


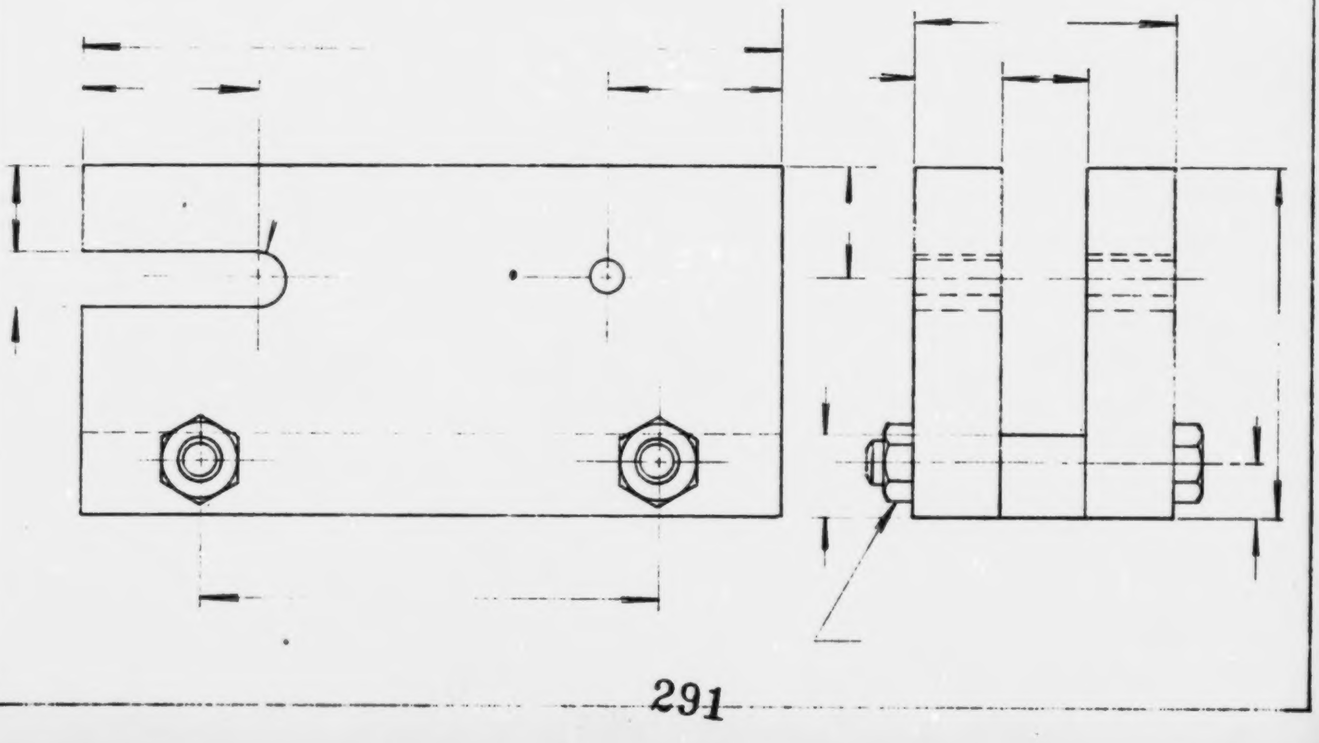
Shear Block
Fixture





Center Shear Block





TEACHER LESSON PLANS FOR MATERIALS ANALYSIS

Day 1

OBJECTIVES:

The student should be able to do the following:

1) identify physical state of two (2) materials given its properties
2) identify the physical state of four (4) common industrial materials
3) identify the difference between thermoset plastics and thermoplastics and give an example of each
4) identify the difference between deciduous and conifer woods
5) define composite materials and distinguish them from other industrial materials
6) identify the difference between ferrous and non-ferrous materials and give examples of each
7) define the word "alloy" and how these differ from other metallic industrial materials
8) list the general properties of industrial materials
9) list examples or products that are manufactured from specific industrial materials.

MATERIALS NEEDED FOR CLASS

Tools, Machines & Materials - none

A.V. Equipment - overhead

A.V. Aids:

Day 1 Transparencies
Samples of gas
Sample of metal
Water in a beaker
Sample of wood or plastic

Student Handouts & Worksheets:

Pretest	1 per student
Student Workbook	1 per student

SUGGESTED CLASS OUTLINE

I. Pretest (20 minutes)

II. Introduce materials & objectives of program (5 minutes)

These are pilot materials prepared under the direction of the Iowa Industrial Arts Cadre. This specifically is a two-week unit concerned with testing materials.

III. Class lecture: Industrial materials (25 minutes)

A. States of matter

1. Pure substances can be found in the three states of matter - gas, liquid, and solids. Each of these has specific properties or characteristics

2. Gases

    a. Name some gases: oxygen, hydrogen, nitrogen, carbon monoxide, carbon dioxide, helium, neon and many more
    b. General properties
        1. Low density 10 to 10 g/cm^3 or 0.06 to 0.6 lbs/ft^3
        2. Diffuse
        3. Expand to fill the container
        4. Take shape of container
        5. Compressable
        6. Fluid or will flow
    c. Theory to explain properties
        1. Particles (atoms or molecules) are separated by large distances
        2. Particles are separate and move independently
        3. Particles are in continuous random motion

3. Liquids

    a. Name some liquids: water, gasoline, cooking oil, alcohol, carbon tetrachloride, paint thinner and many more
    b. General properties
        1. High density 0.1 to 15 g/cm^3 or 6 to 900 lbs/ft^3
        2. Diffuse slowly in other liquids
        3. Take shape of container
        4. Not very compressable
        5. Fluid
    c. Theory to explain properties
        1. Particles (atoms or molecules) are closely packed
        2. Particles are separate and move independently
        3. particles are in continuous random motion, but the speeds are slower

4. Solids

    a. Name some solids: iron, copper, aluminum, ice, brass, sodium chloride, sugar and many more
    b. General properties
        1. High density 0.1 to 23 g/cm^3 or 6 to 1300 lbs/ft^3
        2. Exhibit little diffusion
        3. Retain its own shape
        4. Not very compressable
        5. Are not fluid unless powdered

c. Theory to explain properties
1. Particles (atoms or molecules) are closely packed
2. Particles are held in a crystal structure
3. Particles move back and forth (oscillate)

5. Amorphous Solids

a. In addition to gases, liquids, and solids, there are some materials like glass, rubber or plastic that are rigid but are not really "true" solids. They are called amorphous solids
b. General properties
1. High density 0.1 to 15 g/cm^3 or 6 to 900 lbs/ft^3
2. Exhibit little diffusion
3. Retain its own shape unless heated
4. Usually not extremely fluid unless heated or powdered
5. No melting point, become more fluid (viscous) or decompose
c. Theory to explain properties
1. Particles are molecules that are closely packed
2. The molecules are long chains of atoms that are interlocked or interwoven
3. Particles are in continuous random motion, but the speeds are slower

B. Materials of manufacturing

1. Materials of manufacturing are usually solids or amorphous solids. Furthermore, they can be classified as woods, plastics, metals and composites

2. Plastics: thermoset and thermoplastics

a. Thermoset: Plastics that are molded and set. They cannot be reformed
1. Examples and uses of thermoset plastics
Phenolic - telephone cases, distributor caps, handles, ash trays
Polyester - clothing, boats, corvette body, swimming pools
Malamine - dishware, microwave dishes
Urethane - insulating foam, finishes, cushions & pillow fillings
Epoxy - adhesives
Silicone - water sealant, electrical insulation
b. Thermoplastics: plastics that can be deformed or reformed by heating

1. Examples and uses of thermoplastics
   - Polystrene - packing material, signs, model cars & boats
   - Acrylic - plexiglass
   - Polyethylene- plastic bags, saran wrap, plastic milk containers
   - Polypropylene- plastic tubing
   - Nylon - rope, clothing, bearing

c. General properties of plastics
   - low melting point
   - inexpensive
   - flexible
   - poor electrical conductor
   - lightweight
   - durable (resists wear)
   - medium hardness
   - toxic gases formed
   - poor heat conductor
   - any color

3. Woods: conifers and deciduous

   a. Conifers: needle and cone bearing

      1. Examples and uses of conifers

pine	furniture & construction, framing materials
fir	construction, framing material
cedar	furniture
redwood	decks, outdoor furniture

   b. Deciduous: leaf bearing trees (hard woods)

      1. Examples and uses of deciduous woods

walnut	furniture
oak	furniture
maple	furniture
birch	furniture
hedge	fence posts

      2. General properties of woods
         - low kindling temp
         - expensive
         - flexible
         - poor electrical conductor
         - lightweight
         - very durable
         - medium hardness
         - medium to high tension
         - poor heat conductor

4. Composite materials

   a. One material bonded to a second dissimilar materials

      1. Examples and uses of composite materials

fiber glass	boats, corvette body, body repair
plastic laminates	furniture
boron/metal	golf clubs, tennis rackets
graphite	golf clubs, tennis rackets
teflon	non-stick cookware

b. General properties of composite materials
   - low to high kindling temp
   - less expensive
   - flexible
   - poor electrical conductor
   - lightweight
   - durable
   - high hardness
   - high tension
   - poor heat conductor

5. Metals: ferrous and non-ferrous

a. Ferrous: magnetic metal or iron-like metal
   1. Examples and uses of ferrous

iron	construction material
cast iron	engine block, weights, cast covers

b. Non-ferrous: non-magnetic metals
   1. Examples and uses of non-ferrous

aluminum	electric trans lines, containers, auto parts, boats
copper	flashing, plumbing, art work, elec. wire
lead	shotgun shot, sinkers, radiation shielding, gasoline
zinc	coating, batteries (dry cell)

c. General properties of metal
   - high melting temp
   - expensive
   - flexible
   - good electrical conductor
   - medium to heavy density
   - very durable
   - medium to high hardness
   - high tension
   - good heat conductor

6. Alloys

a. Two (or more) metals mixed to form a material with new properties
   1. Examples and uses of alloys

brass	plumbing, radiators, hardware
bronze	statues, artwork, bearings, marine fittings
solder	electrical connections, plumbing
stainless steel	food processing utensils: pans, trays, dairy equipment, handguns

b. General properties of alloys
   - low to high melting temp
   - expensive
   - flexible
   - electrical conductor
   - low to high density
   - durable
   - low to high hardness
   - high tension
   - heat conductor

ASSIGNMENT FOR NEXT DAY

List five (5) other materials and two (2) uses of each.

REVIEW QUESTIONS & VOCABULARY

1. Identify the three states of matter.
2. Distinguish solids from amorphous solids.
3. Explain the process of hardening thermoset plastics.
4. Name three (3) deciduous woods and three (3) conifers.
5. Explain the factor that differentiates ferrous and non-ferrous metals

alloys
amorphous solids
composite materials
conifer
deciduous
ductile
ferrous
malleable
non-ferrous
thermoplastic
thermoset plastic

REFERENCES

Feirer, John F. Woodworking for Industry, Charles A. Bennett Publishing Co. Inc., Peoria, IL, 1979

Swanson, Robert S. Plastics Technology, McKnight & McKnight Publishing Co., Bloomington, IL, 1965

Tracy, George R. Modern Physical Science, Holt, Rinehart and Winston Publishing, New York, NY, 1979

Walker, John R. Modern Metalworking, Goodhart-Wilcox Co. Inc., South Holland, IL 1976

MATERIALS & EQUIPMENT TO PREPARE

Preparation of game board for horse race game for assignment motivation.
Materials needed:
  Craft paper or white paper (about 36" x 72")
  Magic marker or similar marker
  Oaktag or construction paper for student tokens marked with a team name blank and room for student names
  See Day 2 Lesson Plans for more details
Check film for Day 2

TEACHER SUPPORT MATERIALS

PURE SUBSTANCES

Pure substances (elements or compounds) can be found as a solid, liquid or gas depending on the temperature, the melting point, and boiling point of that substance. That is when the temperature is higher than the boiling point the material is gaseous. At the boiling point both the liquid and gas are present. Between the boiling point and melting point, the substance is liquid. At the melting point, the material is both solid and liquid. Finally, when the temperature is less than the melting point, the substance is solid.

AMORPHOUS SOLIDS

Amorphous solids are not pure substance. The molecules are not uniform. They vary in composition. This is most obvious with the polymer molecules of plastics or rubber. These are long chain molecules that are interlocked or interwoven. When these substances are warmed, the molecules move faster and faster. The material becomes more fluid (less viscous). This continues with further heating unless the substance decomposes (breaks down).

THERMOSET PLASTICS

Thermoset plastics cannot be reused or reprocessed. When a thermoset is molded, it becomes hard in the mold even though the part is still hot. After the chemical action has taken place, the part cannot be softened with heat. The action of a thermoset plastic can be compared to an egg. Once it is cooked, nothing can be done to change it back to a liquid.

THERMOPLASTIC PLASTICS

Thermoplastics can be reprocessed or reused. When heat is applied, a thermoplastic softens or melts. A thermoplastic can be formed into a shape. If it is reheated, it can be formed into a different shape. Thermoplastics can be compared to butter, which can be warmed and reshaped many times.

ALLOYS

An alloy is a combination of two or more metals melted and mixed together in certain proportions. For example, brass is a metal alloy of copper and zinc. When metals are combined to form an alloy, the mechanical and physical properties of the base metals are changed. Substance with more desirable properties are formed.

Examples of alloying:

1. Copper is added to gold to make it harder and wear longer.
2. Copper and zinc are added to silver to lower the melting point for use as a silver solder.

COMPOSITE MATERIALS

Composite materials consist of conventional wood or metal fibers bonded together with plastics matrixes (binding substances).

Examples of composites:

1. Graphite composite for golf clubs, fishing rods and reels and bicycle frames.
2. Carbon composites for aerospace applications.
3. Wood composites for building materials specifically hardboard, particle board, wafer board.
4. Glass fiber composites for boat hulls, vaulting poles and fishing rods.

TRANSPARENCIES

Eight transparencies are supplied to support the lecture for Day I. Use appropriate transparencies depending on the focus of your module - (woods or metals).

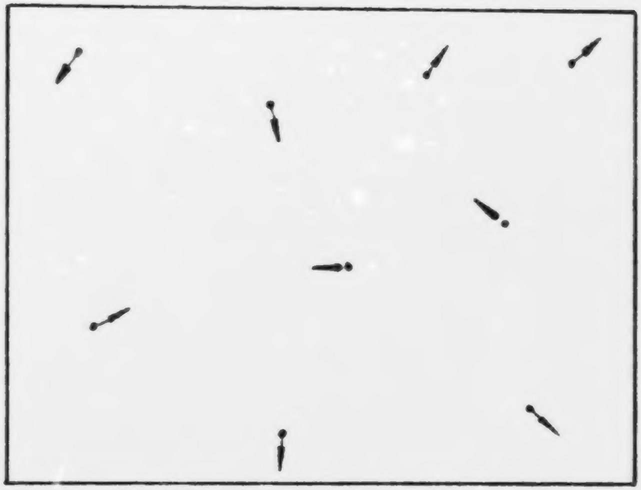
GASES

PROPERTIES

- LOW DENSITY
- DIFFUSE EASILY
- EXPAND TO FILL CONTAINER
- COMPRESSIBLE
- FLUID

THEORY

- PARTICLES ARE SEPARATED BY LARGE DISTANCES
- PARTICLES ARE SEPARATE AND MOVE INDEPENTLY
- PARTICLES ARE IN CONTINUAL RANDOM MOTION



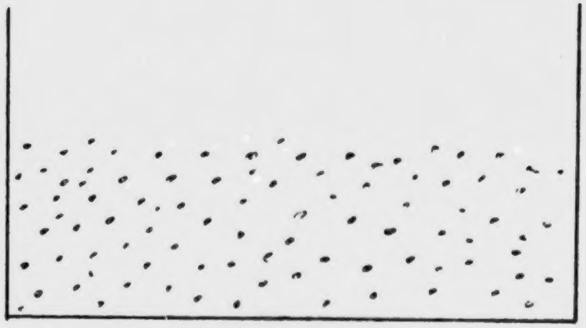
LIQUIDS

PROPERTIES

- HIGH DENSITY
- DIFFUSE SLOWLY
- TAKE SHAPE OF CONTAINER
- NOT VERY COMPRESSIBLE
- FLUID

THEORY

- PARTICLES ARE CLOSELY PACKED
- PARTICLES ARE SEPARATE AND MOVE INDEPENDENTLY
- PARTICLES ARE IN CONTINUAL RANDOM MOTION



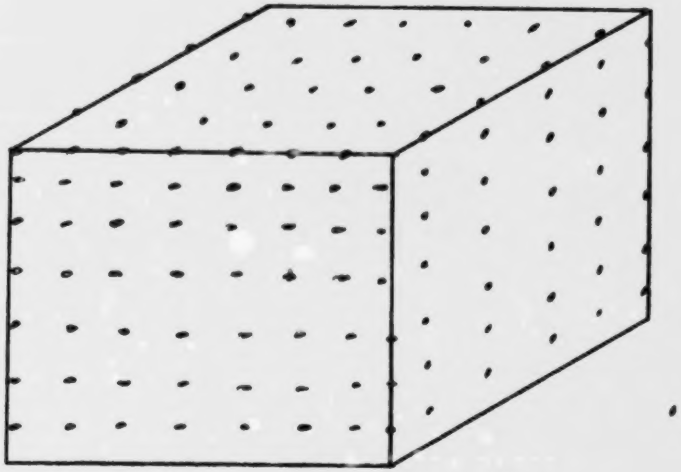
SOLIDS

PROPERTIES

- HIGH DENSITY
- EXHIBIT ALMOST NO DIFFUSION
- RETAIN SHAPE
- NOT VERY COMPRESSIBLE
- NOT FLUID UNLESS POWDERED

THEORY

- PARTICLES ARE CLOSELY PACKED
- PARTICLE ARE HELD IN CRYSALLINE STRUCTURE
- PARTICLES STILL MOVE BUT THE MOTION IS RESTRITED TO OTHER PARTICLES



TYPES OF PLASTICS

THERMOSET

- — PHENOLIC
- — POLY ESTER
- — URETHANE
- — SILICONE

THERMOPLASTIC

- — POLY STYRENE
- — ACRYLIC
- — POLY PROPYLENE
- — POLY ETHYLENE
- — NYLON

TYPES OF WOODS

CONIFERS

— PINE
— REDWOOD
— CEDAR
— FIR
— HEMLOCK

DECIDUOUS

— OAK
— WALNUT
— BIRCH
— MAPLE
— ELM

MATERIAL PROPERTIES

WOODS	PLASTICS
— LOW KINDLING POINT	— LOW MELTING POINT
— MEDIUM TO HIGH TENSILE STRENGTH	— LOW TENSILE STRENGTH
— LOW DURABILITY	— RESISTS WEAR
— RELATIVELY EXPENSIVE	— INEXPENSIVES
— POOR CONDUCTOR	— FLEXIBLE
— MEDIUM HARDNESS	— NON — CONDUCTOR
	— MEDIUM HARNESS

TYPES OF METALS

FERROUS

- STEEL
- CAST IRON

NON FERROUS

- ALUMINUM
- COPPER
- LEAD
- TIN
- ZINC
- NICKEL

MATERIAL PROPERTIES

FERROUS	**NON—FERROUS**
— CONTAINS IRON	— CONTAINS NO IRON
— USUALLY MAGNETIC	— NON MAGNETIC
— CHANGES COLOR WITH TEMP	— MEDIUM MELTING POINT
— HIGH MELTING POINT	— RELATIVELY SOFT
— RELATIVELY HARD	— GOOD ELECTRICAL CONDUCTO
— GOOD ELECTRICAL CONDUCTOR	— GOOD DUCTILITY
— RIDGID	

PRE-TEST

1. A good example of a composite would be:
   a. steel & copper
   b. tin & lead
   c. wood & paper
   d. plastic & wood

2. If your plastic cup gets soft every time you put something hot it, it is
   a. most likely defective
   b. a thermoplastic
   c. a thermoset
   d. made of styrene

3. Deciduous woods include
   a. fir
   b. walnut
   c. cedar
   d. pine

4. A material analyst in a company would be responsible for
   a. testing properties of materials
   b. making suggestions of materials to use for a product
   c. check for safety of materials
   d. all of the above

5. Quality control is involved with
   a. measurement
   b. consumption
   c. speed
   d. force

6. An alloy is made by
   a. combining plastics and metal
   b. welding with oxyacetylene
   c. industry to improve properties of metals
   d. combining gases and amorphour liquids

7. An important consideration when making test specimens is
   a. size
   b. weight
   c. uniformity
   d. cost

8. An example of shear strength is
   a. pounding a nail
   b. bending a nail
   c. chiseling a nail
   d. sawing a nail

9. Most industrial materials are
   a. amorphous solids
   b. gases
   c. liquids
   d. solids

10. Most products used by consumers are made from
   a. metal
   b. wood
   c. composites
   d. plastics

11. Which of the following represent a tensil force?
   a.
   b.
   c.
   d.

12. Metals containing high iron content are classed as
   a. non-ferrous
   b. ferrous
   c. alloys
   d. composites

13. Why do we lay up plywood using alternating layers at right angles to each other
   a. appearance
   b. weight
   c. resistance to insects
   d. strength

14. The concept of pounds per square inch is a measure of
   a. area
   b. pressure
   c. pressure for a given area
   d. none of the above

15. An example of compression is a
   a. a chain to pull a car
   b. bumper of a car being forced against a wall
   c. nail being pulled from a board
   d. bicycle chain during movement

16. Which of the following is not a measure of hardness?
   a. Brinell
   b. Rockwell
   c. Johnson
   d. slerscope

17. Which of the following materials has the highest impact strength?
    a. wood
    b. metal
    c. plastic
    d. glass
18. Which of the following non-ferrous metals is used for beverage cans?
    a. copper
    b. tin
    c. aluminum
    d. brass

19. When a large fish stretches your line to the breaking point you have reached the lines
    a. compression strength
    b. shear strength
    c. tensile strength
    d. abrasion strength

20. The area of a 2" square would be
    a. 2 square inches
    b. 4 square inches
    c. 4 cubic inches
    d. 2 cubic inches

21. Which of the following is a step in laying up fiberglass?
    a. coat plywood with resin
    b. lay on glass cloth
    c. coat glass cloth with resin
    d. all of the above

22. When using fiberglass materials, you should always work in a ___________ area
    a. well lighted area
    b. clean area
    c. well ventilated area
    d. none of the above

23. Metals melt in a temperature range of
    a. 400-3000 F
    b. 0-200 F
    c. 4000-8000 F
    d. 12000-15000 F

24. Another name for bending is
    a. elasticity
    b. melting point
    c. tensile strength
    d. compression strength

True - False

25. T F There are more jobs in testing industrial materials than in production.

26. T F Composite materials use plastic matrixes to bind conventional materials together.

27. T F The best type of tree to plant on the south side of your house would be a deciduous.

28. T F All specimens of a given test must be of the same size and shape.

29. T F Iron is made from steel.

30. T F When cutting material with shears you must allow for the width of the cut (kerf).

31. T F When testing for quality control, it is more reliable to do more than one test.

32. T F The computer disk is similar to a phonograph record.

33. T F It is important to work cooperatively with each other during testing.

34. T F Non-ferrous metals usually melt at lower temperatures than ferrous metals.

35. T F The process of testing specimens will produce exactly the same results each time.

Matching

Application	Material
36. Tires	A. Metal
37. Steering wheels	B. Wood
38. Bicycle spokes	C. Rubber
39. Book pages	D. Plastic
40. Lubricants	E. Motor oil

KEY FOR PRE-TEST

1. d
2. b
3. b
4. d
5. a
6. c
7. c
8. c
9. d
10. c
11. b
12. b
13. d
14. c
15. b
16. c
17. a
18. c
19. c
20. b
21. d
22. c
23. a
24. a
25. F
26. T
27. T
28. T
29. F
30. F
31. T
32. T
33. T
34. T
35. T
36. C
37. D
38. A
39. B
40. E

TEACHER LESSON PLANS FOR MATERIALS ANALYSIS

Day 2

OBJECTIVES:

The student should be able to do the following:

1. identify applications of industrial materials
2. identify at least two (2) career opportunities related with manufacturing materials
3. explain the process utilized to convert a specific material to a product
4. identify five (5) tests utilized in the analysis of industrial materials

MATERIALS NEEDED FOR CLASS

Tools, machines & materials - none

A.V. Equipment - 16 mm film projector or video cassette recorder

A.V. Aids:
16 mm film or video tape (see Teacher Support section)

Student handouts & worksheets:

film quiz	1 per student
crossword puzzle	in student notebook

SUGGESTED CLASS OUTLINE

I. Grouping students (10 min.)

Divide the class into groups according to the following rules:

1. Minimum of 2 students per group
2. Maximum of 7 groups for the entire class

These groups are to work together for the evaluation of homework as well as all production work (preparation of samples and the testing of these samples).

II. Evaluation of homework (15 min.)

The homework is evaluated based on 10 points.

To stimulate competition and pride in the work of the group, a class game is introduced. The recommended one is a "Horse Race" game. See the Teacher Support materials for more details of this game.

III. Film & career information (20-25 min.)

  A. Introduce the film - teacher generated

  B. View the film - teacher generated

  C. Summary of film - teacher generated

  D. Quiz on film - teacher generated

IV. Career information - teacher generated

ASSIGNMENT FOR NEXT DAY

Crossword puzzle over Day 1 & Day 2 vocabulary

REVIEW QUESTIONS & VOCABULARY - teacher generated - related to film

1.
2.
3.
4.
5.

REFERENCES

Feirer, John F. Woodworking for Industry, Charles A. Bennett Publishing Co. Inc., Peoria, IL 1979
Swanson, Robert S. Plastics Technology, McKnight & Mcknight Publishing Co., Bloomington, IL, 1965
Tracy, George R. Modern Physical Science, Holt, Rinehart and Winston Publishing, New York, NY 1979
Walker, John R. Modern Metalworking, Goodheart-Wilcox Co. Inc., South Holland, IL 1976

MATERIALS & EQUIPMENT TO PREPARE

During Day 3, you will demonstrate the techniques required to prepare the test sample stock for materials to be tested. There are two alternatives, either fiberous materials (wood and fiberglass laminated to wood) or metals (one ferrous and one non-ferrous). If you are using the fiberous materials, you should familiarize yourself with the processes used in laying up the fiberglass/wood laminate by preparing a sheet of the material.

For details of preparation of the sample stock and the cutting of the test specimens, see the Day 3 Job Sheet appropriate to your materials.

TEACHER SUPPORT MATERIALS

III. Film & career information (20-25 min.)

   A. Introduce the film - teacher generated

   B. View the film - teacher generated

   C. Summary of film - teacher generated

   D. Quiz on film - teacher generated

IV. Career information - teacher generated

ASSIGNMENT FOR NEXT DAY

Crossword puzzle over Day 1 & Day 2 vocabulary

REVIEW QUESTIONS & VOCABULARY - teacher generated - related to film

1.
2.
3.
4.
5.

REFERENCES

Feirer, John F. Woodworking for Industry, Charles A. Bennett Publishing Co. Inc., Peoria, IL 1979
Swanson, Robert S. Plastics Technology, McKnight & Mcknight Publishing Co., Bloomington, IL, 1965
Tracy, George R. Modern Physical Science, Holt, Rinehart and Winston Publishing, New York, NY 1979
Walker, John R. Modern Metalworking, Goodheart-Wilcox Co. Inc., South Holland, IL 1976

MATERIALS & EQUIPMENT TO PREPARE

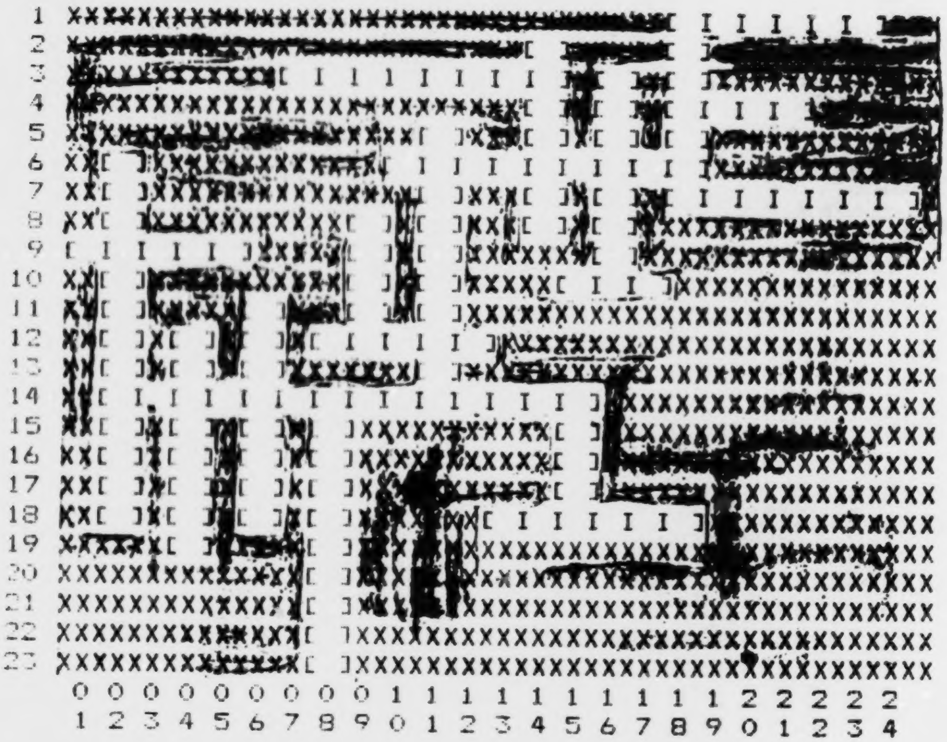
During Day 3, you will demonstrate the techniques required to prepare the test sample stock for materials to be tested. There are two alternatives, either fiberous materials (wood and fiberglass laminated to wood) or metals (one ferrous and one non-ferrous). If you are using the fiberous materials, you should familiarize yourself with the processes used in laying up the fiberglass/wood laminate by preparing a sheet of the material.

For details of preparation of the sample stock and the cutting of the test specimens, see the Day 3 Job Sheet appropriate to your materials.

TEACHER SUPPORT MATERIALS

BOTH [illegible]
& STUDENT WORKBOOK

IND MATERIALS



mistake

see attached sheet.

THE CLUES

ACROSS

[~~1 , 18~~] 1 NONFERROUS METAL
USE-- ELECTRICAL

[~~2 , 7~~] 2 COMPOSITE MATERIAL
USED IN FISHING RODS

[~~4 , 18~~] 3 FERROUS BASE METAL

[~~[illegible] , 10~~] 4 2 MATERIALS JOINED
TO MAKE A NEW ONE

[~~7 , 18~~] 5 CONIFFEROUS WOOD W/
HIGH DECAY RESISTANT

[~~[illegible] , 1~~] 6 NONFERROUS ALLOY OF
COPPER AND ZINC

DECIDUOUS WOOD IN BAT

[~~12 , 8~~] 8 TWO OR MORE METALS
COMBINED IN ONE

[14 , ~~2~~] 9 PLASTIC THAT CAN BE
REMELTED LIKE BUTTER

[~~18 , 13~~] 10 DARK DECIDOUS WOOD
USED IN GUNSTOCKS

DOWN

[~~1 , 10~~] 1 NEEDLE BEARING TREE
SOFTWOOD

[~~1 , 14~~] 2 METALS GROUP WITH
HIGH IRON

[~~3 , 16~~] 3 LEAF BEARING TREE
HARDWOOD

[~~5 , 11~~] 4 METALS GROUP WITH
NO IRON

[~~3 , 2~~] 5 PLASTIC THAT CAN'T
BE REMELTED

[~~8 , 9~~] 6 THERMOPLASTIC USED
FOR CAR SEAT COVERS

[~~11 , 6~~] 7 NONFERROUS METAL USE
FOR BEVERAGE CANS

[~~12 , 4~~] 8 THERMOSET PLASTIC
USE- TELEPHONE CASES

[~~11 , 8~~] 9 ANOTHER WORD FOR
CHARACTERISTICS

[~~14 , 15~~] 10 FERROUS ALLOY MADE
FROM IRON & CARBON

THE ANSWERS

ACROSS

[~~1 , 18~~] 1 COPPER ✓
[~~3 , 7~~] 2 GRAPHITE ✓
[~~4 , 10~~] 3 IRON
[~~6 , 1~~] 4 COMPOSITE
[~~7 , 10~~] 5 REDWOOD
[~~9 , 1~~] 6 BRASS
[~~10 , 15~~] 7 ASH

[~~10 , 15~~]10 WALNUT

DOWN

[~~1 , 10~~] 1 CONIFER ✓
[~~2 , 14~~] 2 FERROUS ✓
[~~3 , 16~~] 3 DECIDOUS DECIDUOUS
[~~5 , 11~~] 4 NONFERROUS
[~~6~~ , 2] 5 THERMOSETTING
[~~8 , 9~~] 6 VINYL
[~~11 , 6~~] 7 ALUMINUM
[~~12 , 4~~] 8 PHENOLIC
[~~14 , 8~~] 9 PROPERTIES
[~~14 , 15~~] 10 STEEL

TEACHER LESSON PLANS FOR MATERIALS ANALYSIS

Day 3

OBJECTIVES

The student should be able to do the following:

1. identify safe operating procedures for the hand and power tools required for this activity (see below for a partial list)
2. correctly use a steel rule to measure within 1/16 inch for all measurements.
   METALS - correctly use a micrometer to measure within 0.001 inch for measurements.
3. define or explain force and tell that pounds is the most common units in the English Measurement System. (optional) For the Standard International System (metric), the unit is the newton (N).
4. understand the need for quality control during the production of sample specimens.
5. WOOD - explain the procedure for laminating fiberglass to plywood.
6. accurately layout and cut the specimens from the appropriate industrial materials.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

LECTURE

Object to measure

WOOD DEMONSTRATION

FIBER GLASS

- plywood
- 5 oz. paper cup
- bench cover, butcher paper
- 3 oz. polyester resin
- scissors
- acetone
- square
- glass cloth
- stir stick
- wax paper
- catalyst or hardener
- steel rule
- paper towel
- saws (band, scroll or hand sabre)

SPECIMEN PREPARATION

- 1/4" x 8" x 15" plywood
- 8" x 15" glass cloth (precut)
- file
- 8" x 15" fiberglass/wood laminate
- pencil or awl
- power sander

METALS DEMONSTRATION

SPECIMEN PREPARATION

ferrous sheet metal (22-26 gauge)	non-ferrous sheet metal (about same)
ferrous rod	3/32" or 1/8" non-ferrous rod (same metal)
pencil or awl	
combination square	tri-square
squaring shear	hacksaw
aviation snips	file

A.V. Equipment - overhead

A.V. Aids:

Day 3 transparencies on measuring & quality control figures

Student handouts & worksheets:

WOOD	
Job Sheet #1A (fiberglass)	1 per student
Job Sheet #1B (specimen prep)	1 per student
METAL	
Job Sheet #1	1 per student

SUGGESTED CLASS OUTLINE

I. Evaluation of homework (10 min.)

- A. Crossword puzzle suggested 20 points.
- B. Remember to mark the Horse Race game.

II. Class lecture: Measurement & Testing

- A. Measurement
  - 1. The importance of measurement
  - 2. Distance (linear) measurement
    - a. illustrate using transparency the different subdivisions (1/2, 1/4, etc.)
    - b. measure a sample using the various scales and record the values
    - c. which of these measurements is correct?
    - d. METALS micrometer measurement
    - e. (optional) Standard International System (Metric System) uses centimeters

3. Force measurement

    a. Defn.: A force is a pull or push
    b. hydraulic pressure
    c. units of measurement - pound (or Standard International is newton).

B. Specimen testing & quality control

1. When preparing or selecting samples for testing, uniform specimens are needed. This means that variations are kept to a minimum to yield valid results.

2. To yield results that are more valid, multiple specimens must be tested. A minimum of three (3) specimens are tested for each test.

3. Test to be performed

	Test	Wood	Metal
a.		1" x 6" formed	1" x 6" formed
b.	compression tests	1" x 2" rect	1" metal rod
c.	shear test	1" c 3" rect	3" metal rod
d.	hardness test	1" x 2" rect	1" x 2" rect
e.	impact penetration test	1" x 2" rect	1" x 2" rect
f.	bending	1" x 6" rect	6" metal rod
g.	kindling or melt	1" x 6" rect	1" x 6" rect

4. Each sample is compared to a quality control pattern for that specimen. This is used to eliminate samples that are misformed.

5. Each sample must be measured as precisely as possible before performing the test. For rule, use 1/16" for this experiment or 0.001" with micrometer.

III. WOOD demonstration for fabrication of testing specimens

A. Demo: construction of fiberglass/wood laminate

Refer to the Fiberglass Job Sheet (#1A)
Stress the safe handling of the materials and tools.
Do prepare a sample of this composite.

B. Demo: construction of the testing specimens

Refer to the Specimen Job Sheet (#1B)
Stress the safe handling of the materials and tools.
Set up either the wood or laminate sample and cut several specimens.

IV. METAL demonstration for fabrication of testing speciments

Construction of the testing specimens
Refer to the Specimen Job Sheet (#1)

ASSIGNMENT FOR NEXT DAY

NO ASSIGNMENT

REVIEW QUESTIONS & VOCABULARY

1. How many 1/16" are in 1/2 inch?
2. Give 4 examples of force measurements.
3. Explain the need for multiple specimen testing.
4. Explain the importance of accuracy in measuring testing.

ALL

awl
quality control
force measurement
tolerance
linear measurement

WOOD

catalyst
laminate
resin

METALS

aviation shears
squaring shears

REFERENCES

Boyd, T. Gardner, Metalworking, Goodheart-Wilcox Co. Inc., South Holland, IL 1982

Jambro, Donald J. Manufacturing Processes ...Plastics, Prentice-Hall Inc., Englewood Cliffs, NJ, 1976

Steele, Jerold L. Fiberglass Projects and Procedures, McKnight & McKnight Publishing Co., Bloomington, IL 1962

Walker, John R. Modern Metalworking, Goodheart-Wilcox Co. Inc., South Holland, IL, 1976

MATERIALS & EQUIPMENT TO PREPARE

1. Check the materials list for Day 4

2. Read the Teacher Support Materials for Day 4 paying special attention to tensile strength, the compression test and the shear test.

3. Check the Universe Force Testing Device for the tensile strength test, the compression test and the shear test.

TEACHER SUPPORT MATERIALS

EVALUATION OF CROSSWORD PUZZLE

There are twenty (20) words on the crossword puzzle. If each word is valued at 1 point, the assignment is worth 20 points. Individual grades could be recorded using any scale. The scores could be converted to letter grades. For each group average the scores to determine the amount of movement of the horse race game markers.

DISTANCE

Distance is a linear measurement between two points. It is only one dimensional and has the English units of inches, feet, yard. The meter, centimeter and kilometer are units in the

FORCE

Force is a push or pull. In the English System, force is measured in pounds (lbs.). The newton (N) is the unit for force using the Standards International (metric) System.

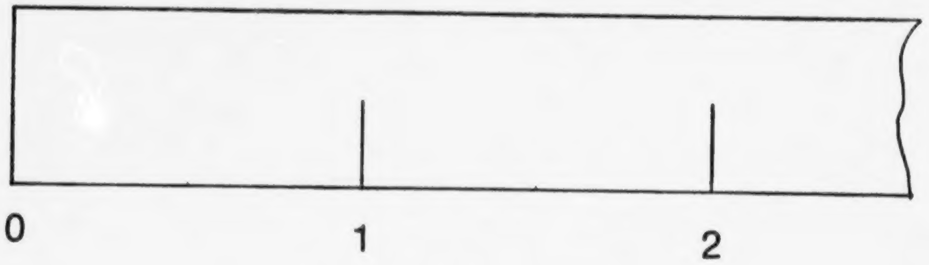
FIBER GLASSING

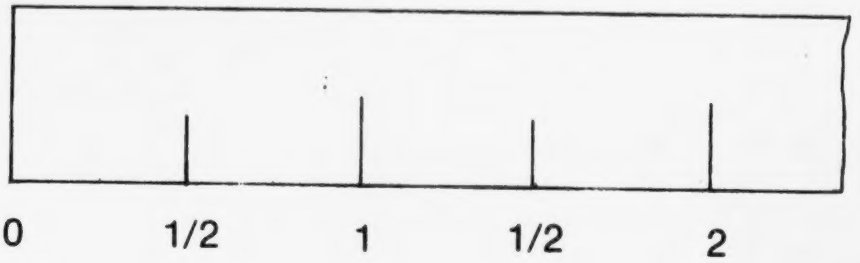
A fiberglass reinforced plastic product is made up of a number of layers of glass cloth material. The glass fibers are saturated with resin. The resin is usually a polyester type resin or another thermoset plastic resin. Generally the higher the glass content the stronger the laminate. The process is somewhat slower than the forming processes for other plastics. Some of the more common products made from fiberglass are boats, dune buggies, snowmobiles and corvette sports car bodies.

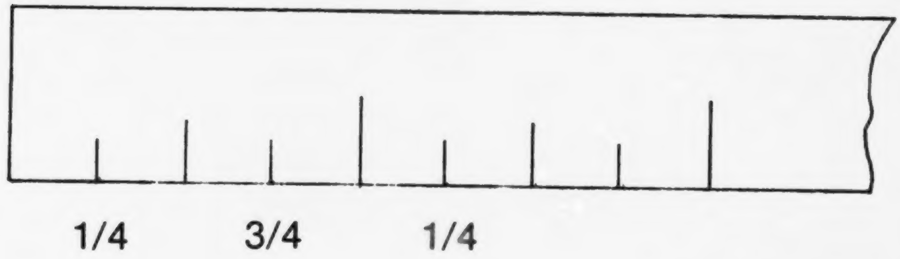
QUALITY CONTROL TEMPLATE

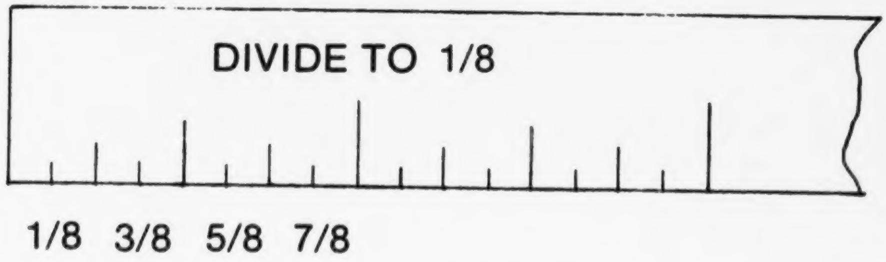
Given on transparency.

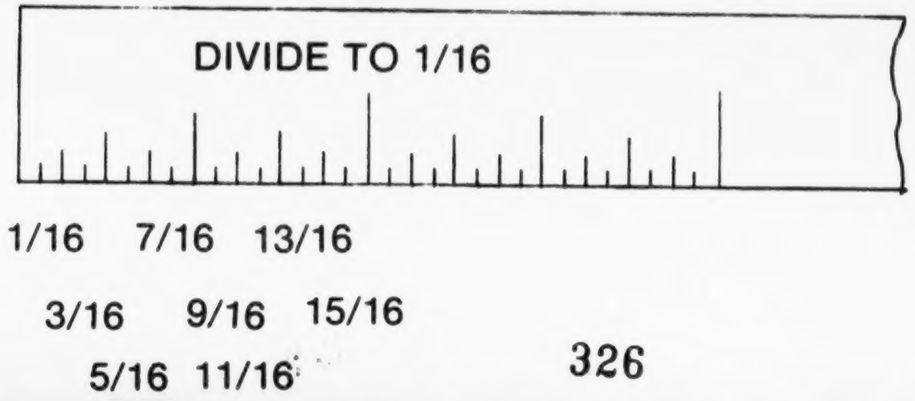
USING A RULE




1/2
1/2


1/4
3/4
1/4

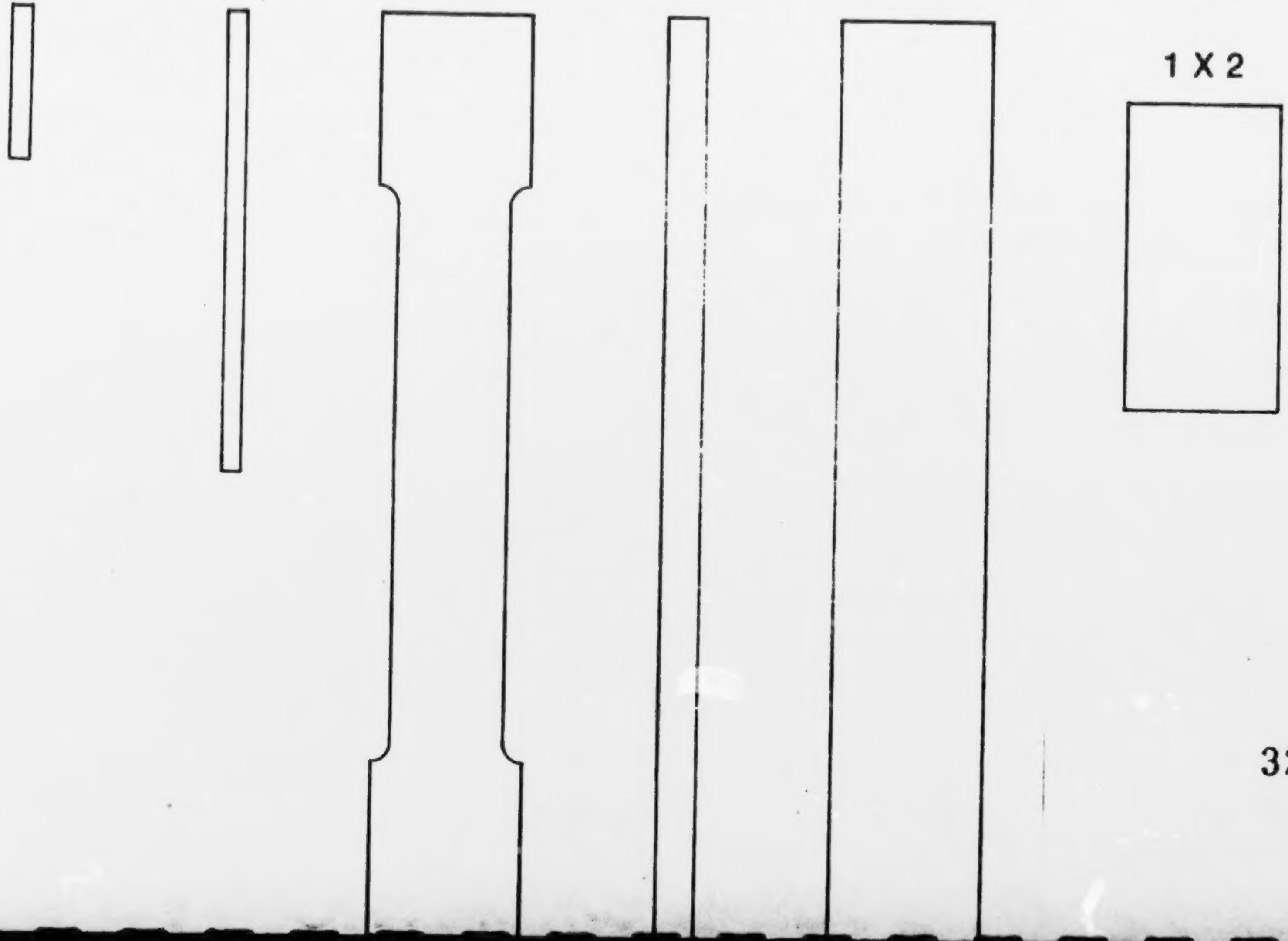

DIVIDE TO 1/8
1/8
3/8
5/8
7/8


DIVIDE TO 1/16
1/16
7/16
13/16
3/16
9/16
15/16
5/16
11/16

QUALITY CONTROL

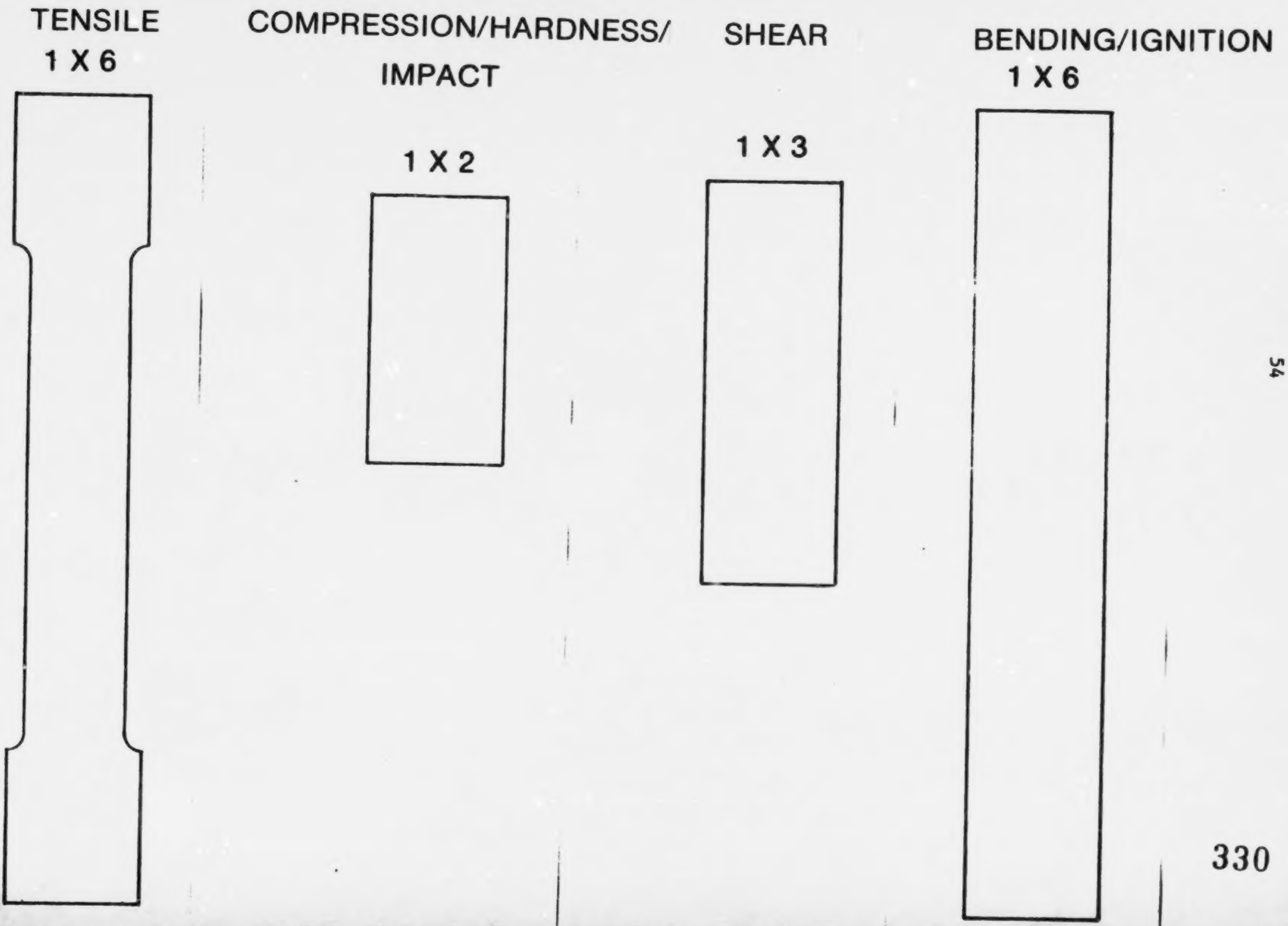
GUAGING FERROUS/NONFERROUS

COMPRESSION	SHEAR	BENDING	TENSILE	MELTING POINT	HARDNESS/ IMPACT
1/8 X 1	1/8 X 3	1 X 6	1/4 X 6	1 X 6	1 X 2



QUALITY CONTROL

GUAGING FIBERGLASS LUMINATE



TENSILE
1 X 6

COMPRESSION/HARDNESS/
IMPACT
1 X 2

SHEAR
1 X 3

BENDING/IGNITION
1 X 6

JOB SHEET #1A

MATERIALS ANALYSIS

FIBERGLASS

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Work in a well-ventilated area.
2. Avoid skin contact with the resin or catalyst.
3. Keep the resin and catalyst away from open flames or fires.
4. Wear safety glasses or goggles and other protective clothing.
5. Use disposable containers to mix the resin and catalyst.
6. Use disposable bench covers. Butcher paper or wax paper will also work.
7. Store the resin and the catalyst in a cool dry place.

TOOLS, MACHINES & MATERIALS

plywood
5 oz. paper cup
bench cover, butcher paper
3 oz. polyester resin
scissors
acetone
square
glass cloth
stir stick
or wax paper
catalyst or hardener
ruler
paper towel
saw

PROCEDURE

A. Wood

1. Lay out 2 pieces of 1/4 inch plywood that measures 8" x 15" using the rule and square.
2. Cut out the above pieces using a saw.
3. Check the dimensions of these sheet to be 8" x 15" within a tolerance of 1/4".

B. Glass cloth

1. Lay out 2 pieces of fiber glass cloth that measures 8" x 15".
2. Cut out the above pieces using a scissors.

C. Plastic coating

1. Fill the 5 oz. paper cup about 2/3 full (3 oz.) of polyester resin.
2. Add 25 drops of catalyst (hardener) and stir until the mixture is uniform.

This is enough resin mixture for the entire project.

D. Lay up of fiberglass/wood laminate

1. Pour about 1/3 of the resin onto one of the 8" x 15" wood pieces and spread evenly over the entire surface. If dry spots develop, you may have to add more resin to those areas.
2. Before the resin cures, lay one piece of the fiberglass cloth over the resin. Remember that the cloth is cut to the same size as the wood.
3. Using the stirring stick, work out all of the air bubbles and completely saturate the fiberglass cloth in the resin coat.
4. Pour another 1/3 of the resin onto this same 8" x 15" wood over the previous layer and spread it evenly over the entire surface.
5. Lay the other piece of the fiberglass cloth over this resin coat.
6. Again using the stirring stick, work out all of the air bubbles and completely saturate the fiberglass cloth in the resin coat.
7. Pour the remainder of the resin onto this same 8" x 15" wood over the previous layers and spread it evenly over the entire surface.

E. Curing

Set this fiberglass/wood laminate aside for at least 40 minutes.

C.T. I.D. of
[illegible]D PACK #2

JOB SHEET # 1B

MATERIALS ANALYSIS

WOOD SPECIMEN PREPARATIONS

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Work in a well-ventilated area.
2. Avoid skin contact with the resin or catalyst.
3. Keep the resin and catalyst away from open flames or fires.
4. Wear safety glasses or goggles and other protective clothing.
5. Observe safety rules when using hand and power tools.
6. Use disposable bench covers. Butcher paper or wax paper will also work.

TOOLS, MACHINES & MATERIALS

1/4" x 8" x 15" plywood
pencil or awl
square
file
8" x 15" fiber glass/wood laminate
rule
saw
sander

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood.

1. Lay out 2 straight sides of a 90 corner on the 8" x 15" sheet. For the fiberglass/wood composite, position this corner in from the edges enough such that the fiber glass is uniformly thick.

For all subsequent measurements, be sure to allow for the kerf (saw cut).

2. Lay out nine (9) 1" x 6" specimen pieces.
3. Lay out nine (9) 1" x 2" specimen pieces.
4. Lay out three (3) 1" x 3" specimen pieces.
5. Cut out all of these 21 specimen pieces with a saw.
6. Select three (3) of the 1" x 6" specimen pieces. Lay out on each the pattern for the tensile test specimen according to Quality Control design.
7. Cut out these tensile specimen pieces with a saw.
8. File or sand all specimen edges to remove all sharp edges.

9. Check each specimen with the Quality Control specs.
10. Re-work all specimens that are NOT within tolerance.

JOB SHEET #1

MATERIALS ANALYSIS

METAL SPECIMEN PREPARATION

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing.
2. Exercise care when handling sharp tool and metal edges.
3. One, and only one person at a time operates the squaring shear.
4. If you are not operating the shearing square, stand outside of the safety area around the shearing square.
5. Keep your hands clear of the cutting blade and the front guard of the squaring shear.

TOOLS, MACHINES & MATERIALS

- ferrous metal sheet
- 3/32" or 1/8" ferrous metal rod
- pencil or awl
- combination square
- squaring shear
- aviation snips
- non-ferrous metal sheet
- 3/32" or 1/8" non-ferrous metal rod
- rule
- tri-square
- hacksaw
- file

PROCEDURE

Follow the procedure given below for both the ferrous metal and the non-ferrous metal.

A. Metal sheet

1. Using the squaring shear, cut a strip 6" wide.

2. Reset the squaring shear to cut eight (8) 1" x 6" metal strips.

3. Cut two (2) of these 1" x 6" strips into 1" x 2" specimen pieces.

4. Select three (3) of the 1" x 6" specimen pieces. Lay out on each of the patterns for the tensile test specimen according to Quality Control design.

5. Cut out these tensile specimen pieces using hand tools.

B. 3/32" or 1/8" metal rod

1. Using a hacksaw, cut three (3) 1" specimen pieces.
2. Using a hacksaw, cut three (3) 3" specimen pieces.
3. Using a hacksaw, cut three (3) 6" specimen pieces.

TEACHER LESSON PLANS FOR
MATERIALS ANALYSIS

Day 4

OBJECTIVES

The student should be able to do the following:

1. define or explain the properties tensile strength, compression and shear.
2. define or explain pressure and tell that pounds per square inch (lbs/in^2, psi) is the most common units used in the English Measurement System. (Optional). For the Standard International System (metric), the unit is a newton persquare meter (N/m^2= Pascal = P) or a newton per square centimeter (N/cm^2= 10,000 Pascals = 10 kiloPascals).
3. define or explain area and tell that square inch (in^2) is the most common unit used to measure area in the English Measurement System. (Optional). For the Standard International System (metric), the unit is a square meter (m^2) or a square centimeter (cm^2).
4. safely use the materials and tools necessary for the fabrication of the fiber glass composite sheet.
5. follow the step by step procedures for the fabrication of the test specimens.
6. work cooperatively within his/her group to facilitate efficient production of the test specimens.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

STUDENT FABRICATION

WOOD FIBER GLASS - Class Quantities

plywood	glass cloth
5 oz. paper cup	stir stick
Bench cover or butcher paper	or wax paper
3 oz. polyester resin	catalyst or hardener
scissors	ruler
acetone	paper towel
square	saw

SPECIMEN PREPARATION - Class Quantities

pencil or awl	rule
square	saw
file	sander

Metals A.V. Equipment - overhead

Metals A.V. Aids:

Day 4 transparencies

Student Handouts & Worksheets:

lecture note sheet	1 per student
quality control sheet	1 per student

SUGGESTED CLASS OUTLINE

I. Class lecture (15 min.)

A. Measurements

1. Area (see teacher support materials)

a. definition:
b. units:

2. Pressure

a. definition:
b. units:

B. Tensile strength (see teacher support materials)

1. Definition:

2. Measurement:

3. Everyday applications

C. Compression (see teacher support materials)

1. Definition:

2. Measurement:

3. Everyday applications

D. Shear (see teacher support materials)

1. Definition:

2. Measurement:

3. Everyday applications

II. Student Working in Laboratory - (35 minutes).

Advise students that the work is more efficiently completed when the labor is divided among the groups members. Watching someone else do the work is a "Waste of Time".

ASSIGNMENT FOR NEXT DAY

1. List a maximum of five (5) other examples for which tensile strength is important.
2. List a maximum of five (5) other examples for which compression is important.
3. List a maximum of five (5) other examples for which shear is important.

REVIEW QUESTIONS & VOCABULARY

1. Determine the cross sectional area of a penny.
2. A specimen with a cross section of 2 square inches (in^2) has a compression strength of 10,000 psi (lbs/in^2). How much force (pounds) can it support without crushing the specimen.
3. Show using diagrams what happens to a tensile specimen, a compression specimen and a shear specimen.

area
cross section
shear
compression
pressure
tensile
cross sectional area
psi

REFERENCES

Earl, Arthur W. Experiments with Materials and Products of Industry, McKnight & McKnight Publishing Co., Bloomington, IL 1960
Materials Technology Laboratory Manual, Vega Engerprises, Inc., Dectur, IL, 1966
Stokes, Vernon L. Manufacturing Materials, Charles E. Merrill Publishing Co., Columbus, OH, 1962

MATERIALS & EQUIPMENT TO PREPARE

1. Check the Materials list for Day 5.
2. Check the Universal Force Testing Device for the tensile, compression and shear tests.
3. Read the Teacher Support Materials for Day 5 paying special attention to the hardness and impact tests.

TEACHER SUPPORT MATERIALS

AREA

1. Definition: is a measure of the amount of surface. It is a two dimensional measurement.

2. Units: square inch (in^2) is most common units used in the English Measurement System. (Optional). For the Standard International System (metric), the unit is a square meter (m^2) or a square centimeter (cm^2).

CROSS SECTION is the area exposed by cutting a sample at a right angle to one of its axes.

PRESSURE

1. Definition: force per unit area = force/area

2. Units: pounds per square inch (lbs/in^2, psi) is the most common unit used in the English Measurement System. (Optional). For the Standard International System (metric), the unit is a newton per square meter (N/m^2= Pascal = P) or a newton per square centimeter (N/cm^2= 10,000 Pascals = 10 kiloPascals).

MECHANICAL PROPERTIES of a material explains how it reacts to various forces acting of the material. Some of these properties are as follows:

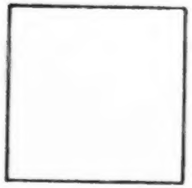
TENSILE STRENGTH is a stretching force that will pull the material apart.

COMPRESSION is a squeezing force that deforms or crushes the material.

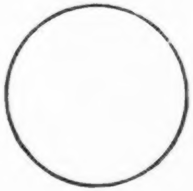
SHEAR results when a force causes the part of the material slides past the rest of the sample.

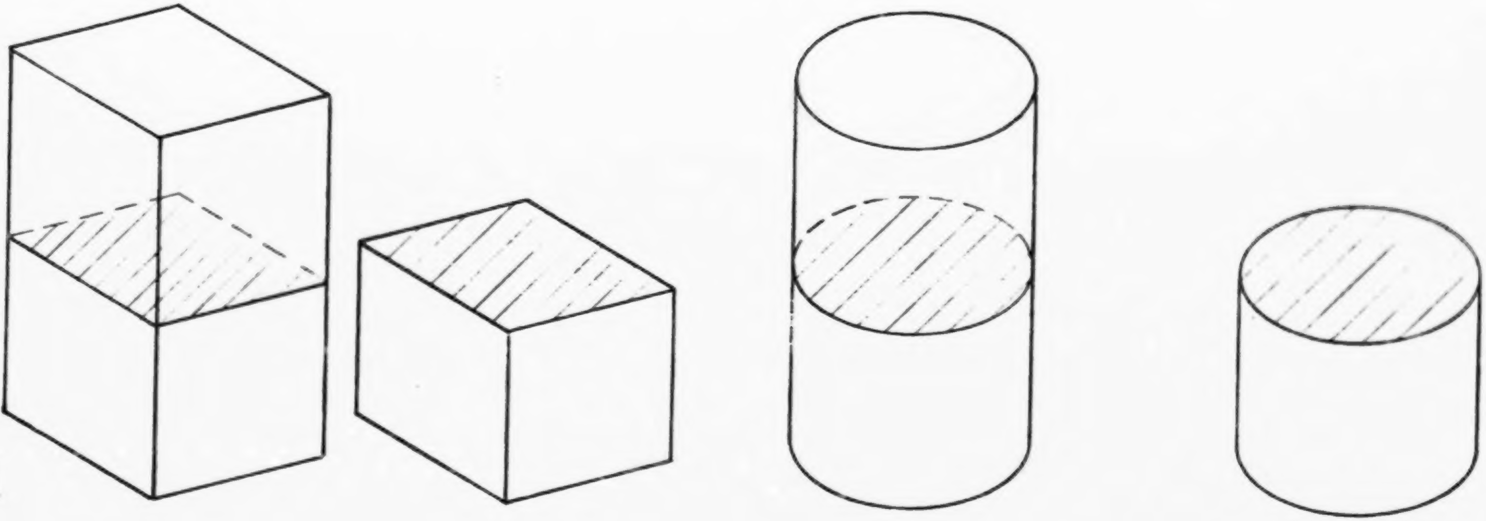
AREA

$A = L \times W$



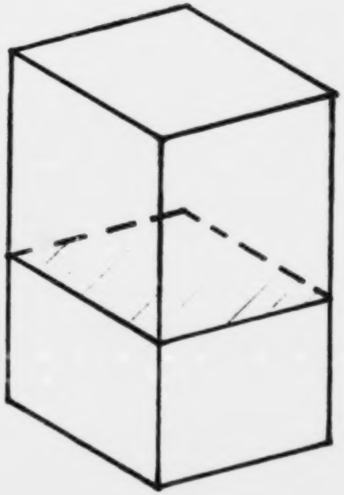
$A = \pi R^2$





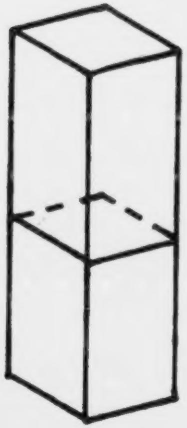
PRESSURE

POUNDS PER SQUARE INCH



BROKE AT 4000 LBS

HOW MANY POUNDS PER SQUARE
INCH WOULD IT HOLD ——— ?

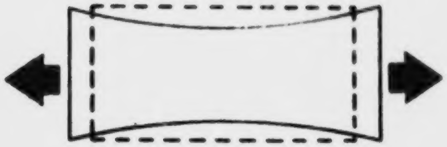


BROKE AT 2000 LBS

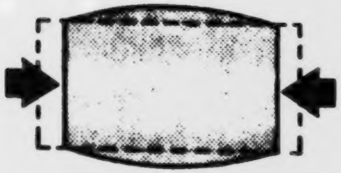
HOW MANY POUNDS PER SQUARE
INCH WOULD IT HOLD ——— ?

FORCE APPLICATIONS

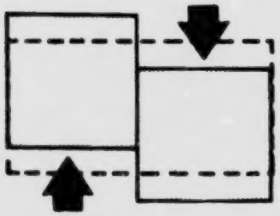
TENSION



COMPRESSION



SHEAR



TEACHER LESSON PLANS FOR
MATERIALS ANALYSIS

Day 5

OBJECTIVES

The student should be able to do the following:

1. define or explain the properties impact and hardness
2. use the testing apparatus for tensile strength, compression and shear
3. observe, accurately measure and record the appropriate data for the tensile, compression and shear failures
4. follow the step-by-step procedures for the fabrication of the test specimens to the Quality Control standards
5. safely use the materials and tools necessary for the layout and cutting the test specimens
6. work cooperatively within his/her group to facilitate efficient production of the test specimens

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

LECTURE & DEMO

Hardness: file
Impact: thin pine (lathe)
Universal testing device
shear block
compression specimens

softwood & hardwood or aluminum & steel
2 supporting objects demonstration
locking pliers (vice grips)
tensile specimens
shear specimens

STUDENT FABRICATION - may not be needed if fabrication is completed

WOODS

FIBERGLASS - class quantities

plywood
5 oz. paper cup
Bench cover or butcher paper
3 oz. polyester resin
scissors
acetone
square

glass cloth
stir stick
wax paper
catalyst or hardener
rule
paper towel
saw

SPECIMEN PREPARATION - class quantities

pencil or awl
square
file

rule
saw
sander

A.V. Equipment - none

A.V. Aids - none

Student Handouts & Worksheets

Lecture note sheet, Quality Control sheets
Testing job sheets for tensile, compression and shear
Student recording sheets for tensile, compression and shear

SUGGESTED CLASS OUTLINE

I. Evaluation of homework (10 min.)

Each example should be valued at 1 point. This is a total of 15 points.

II. Class lecture (5 min.)

A. Hardness

1. Definition:

2. Measurement:

3. Everyday applications:

B. Impact (see teacher support materials)

1. Definition:

2. Measurement:

3. Everyday applications:

III. Demonstration of tests for tensile, compression & shear - (15 min.)

A. Tensile strength (see the tensile strength job sheet #2). Both woods and metals use same form. Record data for computer.

B. Compression (see the compression job sheet #3). Different job sheets for woods and metals.

C. Shear (see the shear job sheet #4). Different job sheets for woods and metals.

IV. Students working in laboratory. (25 min.)

Advise students that the work is more efficiently completed when the labor is divided among the group's members. Watching someone else do the work is a "Waste of Time".

ASSIGNMENT FOR NEXT DAY

1. List a maximum of five (5) other examples for which hardness is important or evident in product designs.

2. List a maximum of five (5) other examples for which impact is important or evident in product designs.

REVIEW QUESTIONS & VOCABULARY

1. When testing is done, why is it important to make a record of accurate observations and measurements?

2. Why are you required to wear safety glasses or goggles during the testing procedures?

3. Why must all of the specimens for a single test be similiar in shape and size?

hardness	impact
quality control	specimen failure

REFERENCES

Earl, Arthur W. Experiments with Materials and Products of Industry, McKnight & McKnight Publishing Co., Bloomington, IL 1960
Materials Technology Laboratory Manual, Vega Enterprises, Inc., Decatur, IL, 1966
Stokes, Vernon L. Manufacturing Materials, Charles E. Merrill Publishing Co., Columbus, OH, 1962

MATERIALS & EQUIPMENT TO PREPARE

1. Check the Materials list for Day 6.

2. Check the Drop Testing device for the hardness and impact tests.

3. Read the Teacher Support Materials for Day 6, paying special attention to the time to kindling and bending tests.

4. Familiarize yourself with the computer & the computer program.

TEACHER SUPPORT MATERIALS

MECHANICAL PROPERTIES of a material explains how the material reacts to various forces acting of the material. These properties are defined as follows:

HARDNESS: a measure of a material's resistance to wear, abrasion, scratching or denting. One method of testing hardness is to draw a file over the material. Use one softwood and a hardwood or aluminum and steel to illustrate the difference. The laboratory method involves the amount of rebound for a metal ball. There are other methods of measuring hardness.

The "Brinell Hardness Tester" uses a steel ball or a diamond under a specific pressure on the material being tested. The size of the indent in the material is measured. The smaller the indentation, the harder the material and the higher is its hardness number. This is a test that can be performed in the field. That is, the equipment is easily transported to the test sight and tested.

The "Rockwell Hardness Tester" is used in a laboratory and the test specimens are brought to the apparatus. It uses either a steel ball or a diamond penetrator to measure hardness. The diamond is used on heat treated steel while the steel ball is used on other materials. A light load is set on the machine and its gauge is set to zero (0). A major load is then applied and removed. A dial on the machine then indicates the "Rockwell Hardness".

A third method uses the "Shore Scleroscope". A diamond-faced hammer is dropped down a tube and impacts on the material being tested. The amount of rebound of the hammer is measured and this indicates the hardness. The principle advantage of this method is the test surface is not marred. (Method being used).

Material hardness is used in manufacturing for quality control. The hardness of a material must be controlled in the manufacture of tools, cars, weapons, construction equipment, appliances, and many other products.

IMPACT is a measure of the materials ability to withstand the sudden impact by dynamic force. Substances are compared by the amount of energy needed to break the sample. This is quite different from the other mechanical properties tests with static or slowly applied load forces. The impact can be demonstrated by breaking a softwood strip using a "karate chop". The Charpy and Izod tests use a hammer mounted on the end of a free-swinging pendulum.

STUDENT LAB, TESTING SHEETS are provided for each of the seven tests. All group members are to actively participate in the testing process. To efficiently complete the tests, the labor is divided among the students. This means that during the testing, all group members are busy doing something, not standing back and watching others do all of the work. Jobs should rotate among the group members. During the tests, there are three principle jobs:

1. Physically operating the apparatus. This is pumping the jack, dropping the ball or things like that.

2. Watching the sample and the gauge.

3. Recording on the lab sheet those observations as well as the measurements.

If there are only 2 members in the group, the recording can be split between the two and combined later between trials. Included in observations are comments about changes in the color or variations in color, stretching, sounds produced as the test progressed, appearance of the material where it failed (broke or bent), warming or cooling of the specimen or anything that occurs that "could" be significant. In addition to these qualitative observations, quantitative observations (measurements) are also noted and recorded in the appropriate areas.

With regard to operating the equipment, stress good safety and operating procedures. Specifically:

1. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possiblity of the sudden ejection to the test specimen from the apparatus.

2. Wear safety glasses or goggles at all times. Even if your group is not working, others are and accidents can happen.

3. Keep your hand away from areas where they could be pinched or squeezed. Pliers could be used to hold specimens in the apparatus when temporary support is needed. The compression test is one example.

4. Observe all the safety rules that apply to the safe operation of all hand and power tools.

After a group has completed all three trials for one of the test, they could go on to another test that is not being used. Alternatively, for many of the tests, a computer provides a follow-up activity. For the tests of tensile strength, compression and shear, the computer calculates the value for that trial and displays the average of all trials entered for that test. The students are not asked to do the calculations nor is that listed in the objectives of this module. For many students the use of the formulas and solving the mathematics could interfere with the emphasis of this module, understanding industrial materials. The computer is used as a "black box" that gives the answer after it has been given the data. The group could use the computer when they finish one of the tests. Before they have completed these tests they will have to use the computer.

JOB SHEET #2
MATERIALS ANALYSIS

TENSILE STRENGTH

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possibility of the sudden ejection to the test specimen from the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device 2-locking pliers (vice grips)
3-tensile specimens either
plywood & fiberglass/wood laminate or ferrous & non-ferrous metal

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood or the ferrous and the non-ferrous metals.

1. Measure the width of the specimen at the most narrow point. The precision for a rule is 1/16 inch. Use 0.001 inch for a micrometer.

2. Measure the thickness of the specimen at the most narrow point. Use the same precision as above.

3. Use the locking pliers to clamp the specimen to the upper part of the apparatus.

4. Make sure the pressure release valve of the hydraulic jack is closed. That is turned clockwise until it is seated.

5. While one team member is watching the specimen, another carefully increases the force by moving the handle up and down. Make note of things that are happening. Others in the group should help with the observations and recording them in the appropriate place.

6. Continue to increase the force until either the specimen fails (breaks) or the limit of the gauge is reached. Of course, record this value and the appearance of the sample now.

7. Now release the pressure valve and raise the apparatus for the next specimen.

8. Repeat this procedure for the other two samples.

9. Finally, repeat all of the steps for the other material.

Tensile Strength

Name ____________________
Partner ____________________
Partner ____________________
Date ____________________
Period ____________________

Material ______________________________

Observations

Specimen	Width	Thickness	Force	Tensile Strength
1				
2				
3				
average				

Observations

Specimen	Width	Thickness	Force	Tensile Strength
1				
2				
3				
average				

Summary

BEST COPY AVAILABLE

JOB SHEET #3
MATERIALS ANALYSIS

WOODS

COMPRESSION - ~~METALS~~

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possibility of the sudden ejection to the test specimen from the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device
3-compression specimens
pliers to hold specimen
plywood & fiberglass/wood laminate

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood.

1. Measure the width of the specimen at the most narrow point. The precision for a rule is 1/16 inch. Use 0.001 inch for a micrometer.

2. Measure the thickness of the specimen at the most narrow point. Use the same precision as the above.

3. Make sure the pressure release valve of the hydraulic jack is closed. That is turned clockwise until it is seated.

4. Use pliers to hold the specimen between the upper plate and the yoke of the apparatus as diagrammed at right.

5. While one team member is watching the specimen, another carefully increases the force by moving the handle up and down. Make note of things that are happening. Others in the group should help with the observations and recording them in the appropriate place.

6. When the specimen is supported in the apparatus release it from the pliers.

7. Continue to increase the force until either the specimen fails (bends or breaks) or the limit of the gauge is reached. Of course, record this value and the appearance of the sample now.

8. Now release the pressure valve and raise the apparatus for the next specimen.

9. Repeat this procedure for the other two samples.

10. Finally, repeat all of the steps for the other material.

Compression

Name ____________________
Partner ____________________
Partner ____________________
Date ____________________
Period ____________________

Material ______________________________

Observations

Specimen	Width	Thickness	Force	Compression
1				
2				
3				
average				

Material ______________________________

Observations

Specimen	Width	Thickness	Force	Compression
1				
2				
3				
average				

Summary

JOB SHEET #4
MATERIALS ANALYSIS

SHEAR - WOOD

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possibility of the sudden ejection ot the test specimen from the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device
3-shear specimens plywood & fiberglass/wood laminate

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood.

1. Measure the width of the specimen. The precision for a rule is 1/16 inch. Use 0.001 inch for a micrometer.

2. Measure the thickness of the specimen. Use the same precision as above.

3. Make sure the pressure release valve of the hydraulic jack is closed. That is turned clockwise until it is seated.

4. Place the specimen inside the slot in the shearing block and place the other piece of metal on top of the sample.

5. Place this arrangement on the lower part of the yoke of the apparatus as diagrammed at right.

6. While one team member is watching the specimen, another carefully increases the force by moving the handle up and down. Make note of things that are happening. Others in the group should help with the observations and record them in the appropriate place.

7. Continue to increase the force until either the specimen shears (breaks) or the limit of the gauge is reached. Of course, record this value and the appearance of the sample now.

8. Now release the pressure valve and raise the apparatus for the next specimen.

9. Repeat this procedure for the other two samples.

10. Finally, repeat all of the steps for the other material.

Shear

Name ____________________
Partner ____________________
Partner ____________________
Date ____________________
Period ____________________

Material ______________________________

Observations

Specimen	Width	Thickness	Force	Shear
1				
2				
3				
average				

Material ______________________________

Observations

Specimen	Width	Thickness	Force	Shear
1				
2				
3				
average				

Summary

JOB SHEET #3
MATERIALS ANALYSIS

COMPRESSION - METALS

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possibility of the sudden ejection to the test specimen from the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device
3-compression specimens
pliers to hold specimen
ferrous and non-ferrous metal

PROCEDURE

Follow the procedure given below for both the ferrous and the non-ferrous metals.

1. Measure the diameter of the specimen at the most narrow point. The precision for a micrometer is 0.001 inch.

2. At a right angle to the first measurement, measure the diameter of the specimen again. Use the same precision as before.

3. Make sure the pressure release valve of the hydralic jack is closed. That is turned clockwise until it is seated.

4. Use pliers to hold the specimen between the upper plate and the yoke of the apparatus as diagrammed at right.

5. While one team member is watching the specimen, another carefully increases the force by moving the handle up and down. Make note of things that are happening. Others in the group should help with the observations and record them in the appropriate place.

6. When the specimen is supported in the apparatus, release it from the pliers.
7. Continue to increase the force until either the specimen fails (bends or breaks) or the limit of the gauge is reached. Of course, record this value and the appearance of the sample now.
8. Now release the pressure valve and raise the apparatus for the next specimen.
9. Repeat this procedure for the other two samples.
10. Finally, repeat all of the steps for the other material.

Compression

Name ______________________
Partner ______________________
Partner ______________________
Date ______________________
Period ______________________

Material ______________________________

Observations

Specimen	Diameter #1	Diameter #2	Force	Compression
1				
2				
3				
average				

Material ______________________________

Observations

Specimen	Diameter #1	Diameter #2	Force	Compression
1				
2				
3				
average				

Summary

JOB SHEET #4
MATERIALS ANALYSIS

SHEAR - METALS

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possibility of the sudden ejection to the test specimen from the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device
3-shear specimens
pliers to hold specimen
ferrous & non-ferrous metal

PROCEDURE

Follow the procedure given below for both the ferrous and the non-ferrous metals.

1. Measure the diameter of the specimen. The precision for a micrometer is 0.001 inch.

2. At a right angle to the first measurement, measure the diameter of the specimen again checking for out of roundness. Use the same precision as before.

3. Make sure the pressure release valve of the hydraulic jack is closed. That is turned clockwise until it is seated.

4. Align the small holes in the shear block with the one in the cutting block and insert the rod through this hole.

5. Place this shear block assembly on the lower part of the yoke of the apparatus as diagrammed at right.

6. While one team member is watching the specimen, another carefully increases the force by moving the handle up and down. Make note of things that are happening. Others in the group should help with the observations and recording them in the appropriate place.

7. When the specimen is supported in the apparatus, release it from the pliers.

8. Continue to increase the force until either the specimen fails (bends or breaks) or the imit of the gauge is reached. Of course, record this value and the appearance of the sample now.

9. Now release the pressure valve and raise the apparatus for the next specimen.

10. Repeat this procedure for the other two samples.

11. Finally, repeat all of the steps for the other material.

Shear

Name ______________________
Partner ______________________
Partner ______________________
Date ______________________
Period ______________________

Material ______________________

Observations

Specimen	Diameter #1	Diameter #2	Force	Shear
1				
2				
3				
average				

Material ______________________

Observations

Specimen	Diameter #1	Diameter #2	Force	Shear
1				
2				
3				
average				

Summary

TEACHER LESSON PLANS FOR
MATERIALS ANALYSIS

DAY 6

OBJECTIVES

The student should be able to do the following:

1. define or explain the properties bending, time to kindling, and melting.
2. use the testing apparatus for hardness and impact.
3. observe, accurately measure and record the appropriate data for the tensile, compression and shear impact and hardness failures
4. safely use the materials and tools necessary for the layout; cut and test the test specimens.
5. work cooperatively within his/her group to facilitate efficient production of the test specimens and specimen testing.
6. correctly enter information into the computer and record the resulting information displayed on the video monitor.
7. correctly name and explain the purpose and function of each of the following parts of a microcomputer: keyboard, data entry for the computer, video monitor, computer displays information and disk drive, magnetic media for program and data storage.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

LECTURE

Bending: metal strip
time to kindling: matches
hardness/impact testing device
pointed metal rod for impact
impact test specimen
computer system

demonstration
metal ball for hardness
hardness test specimens
program disk or cassette tape

A.V. Equipment ~~- overhead projector~~ NONE

A.V. Aids - ~~transparency on bending~~ NONE

Student Handouts & Worksheets

Lecture note sheet
Testing job sheets for hardness and impact
Student recording sheets for hardness and impact

SUGGESTED CLASS OUTLINE

I. Evaluation of homework (10 min.)

Each example should be valued at 1 point. This is a total of 10 points.

II. Class lecture (15 min.)

- A. Bending
  - 1. Definition: — TRANSPARENCY
  - 2. Measurement:
  - 3. Everyday applications
- B. Time to kindling OR MELTING (see Teacher Support Materials)
  - 1. Definition:
  - 2. Measurement:
  - 3. Everyday applications

III. Demonstration of tests for hardness & impact - (10 min.)

- A. Hardness (see the hardness job sheet #6)

  Cautions:
- B. Impact (see the impact job sheet #7)

  Cautions:

IV. Computer aided calculations (15 min.)

(See the Teacher Support Materials)

To aid both you and your students, make sure the computer is already turned on and the program is "loaded" into memory. At this point type RUN and press the (RETURN) key. Demonstrate the program with some of the trials from yesterday.

ASSIGNMENT FOR NEXT DAY

1. List a maximum of five (5) other examples for which bending is important or evident in product designs.
2. List a maximum of five (5) other examples for which time to kindling or melting point is important or evident in product designs.
3. List a maximum of five (5) other examples for use of computers.

REVIEW QUESTIONS & VOCABULARY

1. What is the importance of knowing the hardness ratings of a wood or metal?

2. What is the significance of the time for kindling?

bending
computer drive
time to kindling
video monitor disk drive

REFERENCES

Earl, Arthur W. Experiments with Materials and Products of Industry, McKnight & McKnight Publishing Co., Bloomington, IL 1960
Materials Technology Laboratory Manual, Vega Enterprises Inc., Decatur, IL, 1966
Stokes, Vernon L. Manufacturing Materials, Charles E. Merrill Publishing Co., Columbus, OH, 1962

MATERIALS & EQUIPMENT TO PREPARE

1. Check the materials list for Day 7

2. Check the apparatus for the bending and time to kindling tests.

3. Read the Teacher Support Materials for Day 7 paying special attention to the Game Evaluation and termination.

TEACHER SUPPORT MATERIALS

MECHANICAL PROPERTIES of a material explains how the material reacts to various forces acting of the material. These properties are defined as follows:

BENDING is another name for the modulus of elasticity. It is a measure of the ability of a material to return to its original shape after deforming. The apparatus (see transparency) experts both a compressing force and a tension force on the sample. This modulus of elasticity is a property of the material and remains essentially constant. Heat treating, cold working and even moderate alloying results in little or no change. Regardless of carbon content, all carbon steels are essentially the same. This can also be referred to as the "stiffness" of a material. Everyday examples would include any material that is deformed and returned to its original shape; for example leaf springs and supporting arches.

TIME TO KINDLING or time to ignition depends on many variables which are difficult to control. The principle two are the heat output of the heat source and the distance between the test sample and the flame. When the tests are performed, emphasize that the flame must be kept constant and the specimen should be returned to the same distance from that flame to yield consistant results. There are many applications for this. Children's clothing, toys, and mattresses are just a few. Closely related is the classification of liquids: flammable and combustible.

COMPUTERS are used within this module to aid students with the calculations for the various laboratory test. The computer program is available on disk for the Commodore 64.

We would suggest making a back-up copy of the program disk. Put original in a secure location away from students, electric and magnetic fields.

JOB SHEET #5

MATERIALS ANALYSIS

HARDNESS

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.

TOOLS, MACHINES & MATERIALS

Hardness/ impact testing device   metal ball
3-hardness specimens
plywood & fiberglass/wood laminate or ferrous & non-ferrous metal

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood or the ferrous and the non-ferrous metals.

1. Measure the thickness of the specimen at the most narrow point. The precision for a rule is 1/16 inch. Use 0.001 inch for a micrometer.

2. Position the center of the specimen below the tubing and place the end of the tubing in contact with the sample.

3. Drop the metal ball down the tube. It is important that you just release the ball. Do not attempt to throw it down the tube.

4. Mark the maximum height of the rebounding ball and measure this distance.

   Record all visual observations in appropriate place.

5. Repeat this two more times with this ball and specimen.

6. Repeat this procedure for the other two samples.

7. Finally, repeat all of the steps for the other materials.

Hardness

Name ______________________
Partner ______________________
Partner ______________________
Date ______________________
Period ______________________

Material ______________________________

Observations

Specimen	Thickness	Height #1	Height #2	Height #3
1				
2				
3				
average				

Material ______________________________

Observations

Specimen	Thickness	Height #1	Height #2	Height #3
1				
2				
3				
average				

Summary

JOB SHEET #6
MATERIALS ANALYSIS

IMPACT

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.

TOOLS, MACHINES & MATERIALS

Hardness/impact testing device	metal ball
3-impact specimens	
plywood & fiberglass/wood laminate	or ferrous & non-ferrous metal

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood or the ferrous and the non-ferrous metals.

1. Measure the thickness of the specimen at the most narrow point. The precision for a rule is 1/32 inch. Use 0.001 inch for a micrometer.

2. The specimen must be supported by a block of material with a hole in it. This is needed so that no underlaying support is provided to the material being tested by the apparatus itself.

3. Position the center of the specimen below the tubing and place the end of the tubing in contact with the sample.

4. Drop the pointed metal rod down the tube. It is important that you just release the rod. Do not attempt to throw it down the tube.

   Record all visual observations in appropriate place.

5. Make note of the diameter and the depth of the indentation into the specimen.

6. Repeat this procedure for the other two samples.

7. Finally, repeat all of the steps for the other materials.

Impact

Name
Partner
Partner
Date
Period

Material

Observations

Specimen	Thickness	Diameter	Depth
1			
2			
3			
average			

Material

Observations

Specimen	Thickness	Diameter	Depth
1			
2			
3			
average			

Summary

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TEACHER LESSON PLANS FOR
MATERIALS ANALYSIS

Day 7

OBJECTIVES

The student should be able to do the following:

1. use the testing apparatus for bending (elasticity)
2. WOOD use the testing apparatus for time to kindling
3. METALS use the testing apparatus for melting point
4. observe, accurately measure and record the appropriate data for the tensile, compression, shear, hardness, impact, bending and time to ignition (woods) or melting point (metals) tests
5. work cooperatively within his/her group to facilitate efficient production of the test specimens and specimen testing
6. correctly enter information into the computer and record the resulting information displayed on the video monitor.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

DEMONSTRATION

bending block bending specimen	Universal Force Test Device
TIME TO IGNITION	
propane or oxyacetylene torch	kindling specimen
MELTING POINT oxyacetylene torch	tongs
3 - MELTING SPECIMENS metals	ferrous & non-ferrous

METHOD 1 - Preferred

pyrometer and crucible

METHOD 2 - Alternate Method

stopwatch and fire bricks

STUDENT TESTING

Universal Force Testing Device
shear block
hardness/impact testing device
pointed metal rod for impact
computer system
locking pliers (vice grips)
bending block
metal ball for hardness
program disk or cassette tape

A.V. Equipment - NONE

A.V. Aids - NONE

Student Handouts & Worksheets:

testing job sheets for bending, time to kindling, and melting
student recording sheets for bending, time to kindling, and melting

SUGGESTED CLASS OUTLINE

I. Evaluation of homework (10 min.)

Each example should be valued at 1 point. This is a total of 15 points.

This is the last assignment designed to go with the game. See Teacher Support Material for more information and suggestions.

II. Demonstration of tests for bending & time to kindling (wood) or melting point (metals) - (10 min.)

A. Bending

See the Bending Job Sheet #7. There is one for woods and another for metals.

B. WOOD time to kindling

See the Time to Kindling Job Sheet #8

C. METAL melting point

See the Time to Melting Point Job Sheet #8

III. Student laboratory testing (20 min.)

(See the Day 5 - Teacher Support Materials)

Advise students that they need to work together efficiently. This means division of the labors among all of the group members. Also stress that job responsibilities should be changed after each test. That is, the same student should not always operate the test apparatus. He/she should also be the observer or the recorder periodically.

ASSIGNMENT FOR NEXT DAY - NONE

REVIEW QUESTIONS & VOCABULARY

1. WOOD - based on your observations of the heating of the plywood and the fiberglass/wood composite, how do you account for any variations?
2. METALS - as a general rule, do ferrous or non-ferrous metals bend more easily? Why?
3. METALS - what is the relationship between the time to melting and the melting point?
4. METALS - why do fire brick NOT melt when the flame of a torch is directed on them?

elasticity
acetylene
Fahrenheit
Celcius
fire brick

propane torch
oxyacetylene torch
degrees Fahrenheit
degrees Centigrade
crucible

REFERENCES

Earl, Arthur W. Experiments with Materials and Products of Industry, McKnight & McKnight Publishing Co., Bloomington, IL, 1960
Materials Technology Laboratory Manual, Vega Enterprises, Inc., Decatur, IL, 1966
Stokes, Vernon L. Manufacturing Metals, Charles E. Merrill Publishing Co., Columbus, OH, 1962

MATERIALS & EQUIPMENT TO PREPARE

1. Check the materials list for Day 8
2. Check the computer and the computer program disk
3. Read the Teacher Support Materials for Day 8

TEACHER SUPPORT MATERIALS

GAME TERMINATION

This is the seventh and concluding day for the "Track Test" educational game. The teams have moved their horse along with each successive day's homework. The winning team is the first team finished, or the leading team, if no team has crossed the finish line. This winning team should be rewarded for their achievement. The reward is determined by the individual instructor; however, some motivational award should be presented at this time. Some possibilities are money, lunch, candy assortment or reduction of shop bill. The presentation can be formal or more low key at the teacher's descretion.

JOB SHEET #7
MATERIALS ANALYSIS

BENDING - WOOD

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly., The gauge is more precisely read. Also, this reduces the possiblity of the sudden ejection to the test specimen from the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device
Bending "T" accessory
pliers
3-bending specimens
Bending "U" accessory
foam pad
plywood & fiberglass/wood laminate

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood.

1. Measure the width of the specimen at the center of the sample. The precision for a rule is 1/~~32~~ 16 inch.

2. Measure the thickness of the specimen at the same place. Use the same precision as above.

3. Make sure the pressure release valve of the hydraulic jack is closed. That is, turned clockwise until it is seated.

4. Place the Bending "U" Accessory on the lower part of the yoke of the Universal Testing Device.

5. Place the specimen on the Bending "U".

6. While one team member is holding the Bending "T" above the sample, another student increases the force by moving the handle up and down until contact is made.

7. Continue to increase the force until the specimen touches the foam pad or the limit of the gauge is reached. Record this value and the appearance of the sample now.

8. Release the pressure valve and raise the apparatus for the next specimen.

9. Repeat this procedure for the other two samples.

10. Finally, repeat all of the steps for the other material.

Bending

Name ______________________
Partner ______________________
Partner ______________________
Date ______________________
Period ______________________

Material ______________________

Observations

Specimen	Width	Thickness	Force	Bending
1				
2				
3				
average				

Material ______________________

Observations

Specimen	Width	Thickness	Force	Bending
1				
2				
3				
average				

Summary

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JOB SHEET #7
MATERIALS ANALYSIS

BENDING - METAL

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while force is applied because of the danger of being pinched or squeezed.
4. Operate the jack slowly. The gauge is more precisely read. Also, this reduces the possibility of the sudden ejection to the test specimen form the apparatus.

TOOLS, MACHINES & MATERIALS

Universal Testing Device
Bending "T" Accessory
pliers
3-bending specimens
Bending "U" Accessory
foam pad
ferrous rod & non-ferrous rod

PROCEDURE

Follow the procedure given below for both the ferrous rod and the non-ferrous rod.

1. Measure the diameter of the specimen. The precision for a micrometer is 0.001 inch.

2. At a right angle to the first measurement, measure the diameter of the specimen again. Use the same precision as before (checking for out of roundness).

3. Make sure the pressure release valve of the hydraulic jack is closed. That is, turned clockwise until it is seated.

4. Place the Bending "U" Accessory on the lower part of the yoke of the Universal Testing Device.

5. Place the specimen on the Bending "U".

6. While one team member is holding the Bending "T" above the sample, another student increases the force by moving the handle up and down until contact is made.

7. Continue to increase the force until the specimen touches the foam pad or the limit of the gauge is reached. Of course, record this value and the appearance of the sample now.
8. Now release the pressure valve and raise the apparatus for the next specimen.
9. Repeat this procedure for the other two samples.
10. Finally, repeat all of the steps for the other material.

Bending

Name ____________________
Partner ____________________
Partner ____________________
Date ____________________
Period ____________________

Material ______________________________

Observations

Specimen	Diameter #1	Diameter #2	Force	Bending
1				
2				
3				
average				

Material ______________________________

Observations

Specimen	Diameter #1	Diameter #2	Force	Bending
1				
2				
3				
average				

Summary

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JOB SHEET #8

MATERIALS ANALYSIS

TIME TO KINDLING

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while heat is applied because of the danger of being burned.

TOOLS, MACHINES & MATERIALS

metal stand
propane torch
3-kindling specimens
metal clamp, pliers or tongs
stopwatch
plywood & fiberglass/wood laminate

PROCEDURE

Follow the procedure given below for both the plywood sheet and the composite of fiberglass and wood.

1. The best method of holding the test specimen is to use a metal stand and a clamp to hold the sample securely. Alternately, hold it with tongs or pliers.

2. Ignite the propane torch and adjust it to a low flame.

3. Zero the stopwatch.

4. Hold the torch perpendicular to the specimen surface with the tip of the flame 1 inch from the specimen for 2 seconds.

5. Remove the torch for 2 seconds. Determine if the material continues to burn.

6. If the sample did not ignite, repeat the heating for 2 additional seconds. Return the burner to the same distance from the sample at the same location. Again, remove the burner for 2 additional seconds. Continue the 2 second heatings until the sample continues to burn or support combustion. Record your observations and the total time for the ignition.

7. Repeat this procedure for the other two samples.

8. Finally, repeat all of the steps for the other material.

Time to Kindling

Name ______________________
Partner ______________________
Partner ______________________
Date ______________________
Period ______________________

Material ______________________________

Observations

Material ______________________________

Observations

Summary

JOB SHEET #8
MATERIALS ANALYSIS

MELTING POINT

SAFETY PRECAUTIONS

You should be especially careful to observe the following safety practices during this job.

1. Wear safety glasses or goggles and other protective clothing at all times. Even if your group is not working, others are and accidents can happen.
2. Observe safety rules when using the Testing Device, hand and power tools.
3. Keep your hands clear of the apparatus while heat is applied because of the danger of being burned.

TOOLS, MACHINES & MATERIALS

GENERAL

oxyacetylene torch
3-melting specimens
torch
ferrous & non-ferrous metals

METHOD 1 - Preferred

pyromete and crucible

METHOD 2 - Alternate Method

stopwatch and fire brick

PROCEDURE

Follow the procedure given below for both the ferrous and the non-ferrous metal.

PYROMETER METHOD

1. Place the specimen in a crucible.
2. Light the oxyacetylene torch and adjust for a hot flame.
3. Heat the crucible until the material melts. Place the pyrometer into the molten metal.
4. Remove pyrometer every ten seconds to determine if the metal has solidified.
5. Record temperature at which metal solidifies.
6. Repeat this procedure for the other two samples.

7. Finally, repeat all of the steps for the other materials.

STOPWATCH METHOD

1. Place the specimen on a fire brick.
2. Light the oxyacetylene torch and adjust to a neutral flame.
3. Zero the stopwatch.
4. Direct the torch's heat onto the specimen at a distance of about 3 inches and start the stopwatch.
5. Continue to hold the torch in place until the metal begins to melt. Record your observations and the time for the material to melt.
6. Repeat this procedure for the other two samples.
7. Finally, repeat all of the steps for the other material.

Melting Point

Name ____________________
Partner ____________________
Partner ____________________
Date ____________________
Period ____________________

Material ______________________________

Observations

Trial 1 Melting Point (or Time to Melt) ____________________
Trial 2 Melting Point (or Time to Melt) ____________________
Trial 3 Melting Point (or Time to Melt) ____________________

Material ______________________________

Observations

Trial 1 Melting Point (or Time to Melt) ____________________
Trial 2 Melting Point (or Time to Melt) ____________________
Trial 3 Melting Point (or Time to Melt) ____________________

Summary

TEACHER LESSON PLANS FOR MATERIALS ANALYSIS

DAY 8

OBJECTIVES

The student should be able to do the following:

1. correctly use the test equipment for all of the seven (7) laboratory tests: tensile, compression, shear, hardness, impact, bending, and time to kindling
2. Observe, accurately measure and record the appropriate data for the tensile, compression, shear, hardness, impact, bending, and time to kindling tests
3. work cooperatively within his/her group to facilitate efficient production of the test specimens and specimen testing
4. correctly enter information into the computer and record the resulting information displayed on the video monitor
5. draw conclusions concerning the tensile, compression, shear, hardness, impact, bending, and time to kindling for the two materials tested.
6. work cooperatively within his/her group to organize test results for presentation to the seminar.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

STUDENT TESTING

Universal Force Testing Device
Shear Block
hardness/impact testing device
pointed metal rod for impact
computer system
locking pliers (vice grips)
bending block
metal ball for hardness
propane or oxyacetylene torch
program disk or cassette tape

A.V. Equipment - NONE

A.V. Aids - NONE

Student Handouts & Worksheets

seminar outline

SUGGESTED CLASS OUTLINE

- I. Lecture/discussion (10 min.)
  - A. Seminar Organization
    - 1. Explain the purpose and setting of the seminar
    - 2. Explain the role of seminar and their evaluation.
    - 3. Seminar outline
  - B. Discuss Testing Stations
    - 1. Check progress of groups - successes and problems with tests
    - 2. Identify problem areas
- II. Student Laboratory Testing (40 min.)

  See the Day 5 Teacher Support Materials

  Provide individual assistance to groups that are having difficulty with particular experiments. However, do not do the work for the students; the students need to do the work. Also talk to groups in which the work is not divided among the group members or job responsibilities are not changed after each test.

ASSIGNMENT FOR NEXT DAY

Gather information needed for your seminar topic.

REVIEW QUESTIONS & VOCABULARY - NONE

REFERENCES

Earl, Arthur W. Experiments with Materials and Products of Industry, McKnight & McKnight Publishing Co., Bloomington, IL, 1960

Materials Technology Laboratory Manual, Vega Engerprises Inc., Decatur, IL, 1966

Stokes, Vernon L. Manufacturing Materials, Charles E. Merrill Publishing Co., Columbus, OH, 1962

MATERIALS & EQUIPMENT TO PREPARE

1. Check the materials list for Day 9.
2. Check the computer and the computer program disk.
3. Read the Teacher Support Materials for Day 9.

TEACHER SUPPORT MATERIALS

The seminar is an organized gathering of people brought together to discuss one or more topics or presentations. The initial presentation is just the beginning for a much more involved discussion. The seminar method allows students to add more information themselves, to explore applications and relationships, to clarify points, to draw together and reach conclusions, and to broaden their perspective about a topic. The seminar works well as a concluding activity where the student will be more knowledgeable in the subject.

The seminar is normally conducted around a table with the presenting group acting as the leader. The teacher's role should only be to initially introduce the format with emphasis given to all students participating. Props such as namecards, notepads or pencils can be used at the instructors discretion. In summary, the teacher should close by clarifying points and offering a word of appreciation to the participants.

SEMINAR IDEAS

Suggested hints for the seminar include:

1. Try to stimulate as much involvement as possible.
2. Avoid arguments.
3. Try to avoid a monopoly of discussion by one group -- allow varying points.
4. Keep on the topic.

STUDENT SEMINAR OUTLINE

NAME______________________________

ORDER_______________

TESTS______________________________

Guidelines:

1. Students should divide responsibility so all participate.
2. Students should report only on the two tests assigned.
3. Students should use visual aids in their presentation and describe fully their results & observations.
4. Students should discuss how their results compared with other groups.
5. Space below should be used for presentation outline and notes.

TEACHER LESSON PLANS FOR
MATERIALS ANALYSIS

DAY 9

OBJECTIVES

The student should be able to do the following:

1. correctly use the test equipment for all of the seven (7) laboratory tests: tensile, compression, shear, hardness, impact, bending, and time to kindling
2. observe, accurately measure and record the appropriate data for the tensile, compression, shear, hardness, impact, bending, and time to kindling tests
3. work cooperatively within his/her group to facilitate efficient production of the test specimens and specimen testing
4. correctly enter information into the computer and record the resulting information displayed on the video monitor
5. draw conclusions concerning the tensile, compression, shear, hardness, impact, bending, and time to kindling for the two materials tested.
6. work cooperatively within his/her group to organize test results for presentation to the seminar.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials

STUDENT TESTING

Universal Force Testing Device
Shear Block
hardness/impact testing device
pointed metal rod for impact
computer system
locking pliers (vice grips)
bending block
metal ball for hardness
propane or oxyacetylene torch
program disk or cassette tape

A.V. Equipment - NONE

A.V. Aids - NONE

Student Handouts & Worksheets

Seminar outline

SUGGESTED CLASS OUTLINE

I. Discuss testing stations (5 min.)

   A. Check progress of groups - successes and problems with tests

   B. Identify problem areas

II. Student laboratory testing (40 min.)

   See the Day 5 - Teacher Support Materials

   Provide individual assistance to groups that are having difficulty with particular experiments. However, do not do the work for the students; the students need to do the work. Also, talk to groups in which the work is not divided among the group members or job responsibilities are not changed after each test.

ASSIGNMENT FOR NEXT DAY

Prepare your seminar presentation. The seminar is tomorrow, Day 10.

REVIEW QUESTIONS & VOCABULARY - NONE

REFERENCES

Earl, Arthur W. Experiments with Materials and Products of Industry, McKnight & McKnight Publishing Co., Bloomington, IL, 1960
Materials Technology Laboratory Manual, Vega Enterprises, Inc., Decatur, IL, 1966
Stokes, Vernon L. Manufacturing Materials, Charles E. Merrill Publishing Co., Columbus, OH, 1962

MATERIALS & EQUIPMENT TO PREPARE

1. Check the materials list for Day 10.

2. Check the computer and the computer program disk.

TEACHER SUPPORT MATERIALS

TEACHER LESSON PLANS FOR
MATERIALS ANALYSIS

DAY 10 - WOOD

OBJECTIVES

The student should be able to do the following:

1. describe the setting and purpose of a seminar
2. present laboratory test results and analysis in a seminar setting
3. analyze fellow students presentations of laboratory test results
4. describe the reasons for difference in laboratory test results among the groups and also with the accepted values (standard) for these quantities.

MATERIALS NEEDED FOR CLASS

Tools, machines & materials - NONE

A.V. Equipment - overhead projector

A.V. Aids

Clear plastic sheets (blank transparencies)
Transparency pen(s)

SUGGESTED CLASS OUTLINE

I. Seminar (25 min.)

  A. Teacher briefly explains the seminar

  B. Student presentations & discussions (computer is available to check calculations)

  C. Teacher summary

II. Post test (20 min.)

ASSIGNMENT FOR NEXT DAY - NONE - unit is finished

REVIEW QUESIONS & VOCABULARY - NONE

REFERENCES

Maley, Donald A. The Industrial Arts Teacher Handbook, Allyn & Bacon Inc., Boston, MA, 1978

TEACHER SUPPORT MATERIALS

TECHNICAL DATA SHEET

TECHNICAL DATA SHEET

DAY 10

MATERIAL	TENSILE PSI	COMPRESSION PSI	SHEAR PSI	Modulus of Elasticity BENDING PSI	MELTING POINT	TIME TO IGNITION	HARDNESS	IMPACT
STEEL	70,000	7,000	52,500	30,000,000	2,500			
ALUMINUM	35,000	35,000	26,000	11,000,000	1,217			
BRONZE	39,000	39,000	29,000	15,000,000	1,680			
BRASS	39,000	39,000	29,000	13,000,000	1,700			
TIN	32,000	32,000	34,000	12,000,000	450			
COPPER	42,000	42,000	35,000	17,000,000	1,982			
NICKEL	6,500	6,500	12,000	30,000,000	2,646			
PLYWOOD			1800 PSI	1,800,000				
PLYWOOD/LAMINATE			1800 PSI	2,200,000				

POST TEST

1. The strength of fiberglass comes from the
    a. plastic
    b. glass cloth
    c. catalyst
    d. acetone

2. An example of a laminate is
    a. plywood
    b. brass
    c. glass cloth
    d. acrylic sheet

3. Crossectional area is defined as
    a. the area of a cross
    b. the area found by multiplying the length by twice the width
    c. the area exposed by making a cut 90 degrees with one of the axis
    d. the total surface area of an object

4. If you need metal to make a knife, the most important property would be
    a. hardness
    b. tensile strength
    c. modulus of elasticity
    d. shear strength

5. To increase tensile strength, one could
    a. increase the crossectional area of a piece
    b. increase the width of the piece
    c. change the diameter
    d. make it a composite

6. In preparing shear specimens, the most important measurement is
    a. the length
    b. the diameter
    c. the melting temperature
    d. none of the above

7. Observations in materials testing should include all but
    a. sight
    b. hearing
    c. smell
    d. taste

8. A seminar is
    a. used to make a composite
    b. a way of sharing information
    c. a school for ministers
    d. the best method of testing materials

9. A difference in test results can be accounted for by
   a. differences in material quality
   b. inaccurate observations
   c. incorrect measurements
   d. all of the above

10. Laminating fiberglass to wood
    a. reduces the tensile strength
    b. increases the bending strength
    c. increases the hardness
    d. increases the impact strength

11. When two or more metals are mixed together to form a new material the end result is called a/an
    a. alloy
    b. non-ferrous
    c. ferrous
    d. basemetal

12. Which of the plastic types listed below is an example of a thermoset?
    a. acrylic
    b. nylon
    c. epoxy
    d. polyethylene

13. What is the purpose of the racing game?
    a. motivate students
    b. busy work
    c. final grade for the students
    d. none of the above

14. Fiberglass is used extensively in the manufacturing of
    a. books
    b. boats
    c. barges
    d. bricks

15. Sheetmetal thickness is measure in
    a. gauge number
    b. millimeters
    c. decimal
    d. fractions

16. Which of the following non-ferrous metals is used for beverage cans?
    a. copper
    b. tin
    c. aluminum
    d. brass

17. The process of checking the accuracy of manufactured products is called
    a. production planning
    b. quality control
    c. production design
    d. processing materials

18. An example of shear properties would be
    a. using a hammer
    b. using a pair of pliers
    c. using a screwdriver
    d. using a pair of scissors

19. When doing tensile strength testing on the test equipment, you need to have the specimen in place with which of the following?
    a. fingers
    b. pliers
    c. glue
    d. clamping-type pliers

20. When using the bank saw, the following is a safety rule to remember
    a. pull blade guide down
    b. keep fingers on edge of piece
    c. wear safety glasses
    d. all of the above

21. Which of the following hardness testers uses a rebounding hammer to measure hardness?
    a. Rockwell hardness tester
    b. Brinell hardness tester
    c. Shore scleroscope
    d. Stethoscope

22. For the test dealing with time of kindling, you need one of the following
    a. heat source
    b. water source
    c. asbestos gloves
    d. none of the above

23. The storage device used on the computer is
    a. the monitor
    b. the keyboard
    c. the interface
    d. the disk

24. When testing for time to kindling, apply the heat source to the specimen at what intervals?
    a. 10 seconds
    b. 15 seconds
    c. 2 seconds
    d. 1 second

25. When observing the bending test, the specimen needs to be bent until it does what?
    a. breaks
    b. touches the foam rubber
    c. deforms
    d. none of the above

26. Metals melt in a temperature range of
    a. 400 - 3000°F
    b. 0 - 200°F
    c. 4000 - 8000°F
    d. 12000 - 15000°F

27. Another name for bending is
    a. elasticity
    b. melting point
    c. tensile strength
    d. compression strength

28. Which of the following has a high elasticity?
    a. cast iron
    b. aluminum
    c. spring steel
    d. wood

TRUE-FALSE

29. T F Some woods can be classified as alloys.

30. T F If a fiberglass boat hit a rock, the hole can be repaired rather easily.

31. T F The concept of a fist hitting a punching bag is shear force.

32. T F When mixing the liquid part of fiberglass construction, you must mix resin and hardener together.

33. T F Each group should make three specimens for testing.

34. T F The quality control sheet is used to check the size of specimen.

35. T F The computer disk is similiar to a phonograph record.

MATCH THE FOLLOWING PARTS OF AN INCH WITH THE CORRECT ANSWER

36. a. 3/4

37. b. 1/8

38. c. 7/8

39. d. 7/16

40. e. 11/16

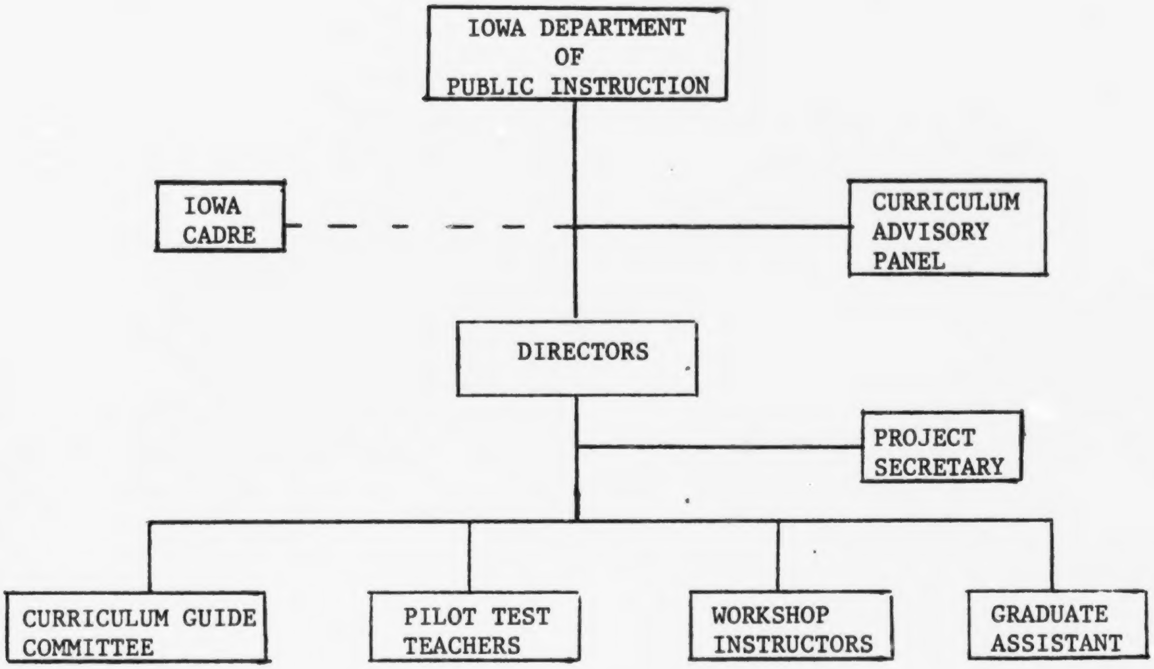
Check

Answer sheet

APPENDIX I

PROJECT PERSONNEL CHART

PERSONNEL ORGANIZATION CHART
1984-85



APPENDIX J

SAMPLE OF TEST ITEM BANK

CLASSIFICATION BY CONCEPT

I. MANUFACTURING

10x	Generic
11x	Tools
12x	Materials
13x	Processes, Machining
14x	Design / Research & Development
15x	History
16x	Management
17x	Service & Maintenance
18x	Human Resources
19x	Safety & Enviroment

II. CONSTRUCTION

20x	Generic
21x	Tools
22x	Materials
23x	Processes
24x	Design / Research & Development
25x	History
26x	Management
27x	Service & Maintenance
28x	Human Resources
29x	Safety & Enviroment

III. CCOMMUNICATION

30x	Generic
31x	Tools
32x	Materials
33x	Pocesses
34x	Design / Researh and Development
35x	History
36x	Management
37x	Servie & Maintenane
38x	Human Resources
39x	Safety & Enviroment

IV. ENERGY AND POWER

40x	Generic
41x	Tools
42x	Materials
43x	Processes
44x	Design / Research & Development
45x	History
46x	Management
47x	Service & Maintenance
48x	Human Resources

49x Safety & Enviroment

V. TRANSPORTATION

50x	Generic
51x	Tools
52x	Materials
53x	Processes
54x	Design / Research & Development
55x	History
56x	Management
57x	Service & Maintenance
58x	Human Resources
59x	Safety & Enviroment

CLASSIFICATION BY TOPIC

I. MANUFACTURING

10x Machining of Metal
11x Sheet Metal
12x Welding
13x Metal Casting, Forging, Rolling, Extrusion (Forming)
14x NC, CNC, Robotics, Automation
15x Wood - Nonconstruction
16x Plastics
17x Ceramics
18x Glass
185 Fiber Glass
19x Scheduling, Planning, Testing

II. CONSTRUCTION

20x Framing & Finishing
21x Plumbing
22x Electrical Wiring
23x Masonry
24x Roofing
25x Excavation
26x Landscaping
27x Architectual Drawing

III. COMMUNICATION

30x Printing (Graphic Reproduction), Silk Screen, Block Printing
31x Photography (White & Black)
32x Photography (Color)
33x Graphic Design
34x Technical Drawing (Basic)
35x Engineering Drawing
36x Architectual Drawing
37x Computer Graphic, CAD

IV. ENERGY AND POWER

40x Solar Energy
41x Fossil Fuels (Coal, Oil, Gas)
42x Hydroelectric
43x Wind
44x Hydraulics, Pneumatics (Fluid Plwer)
45x Electricity (House Wiring, Basic Motors, Generators)
46x Electronics (Communications, TV, etc.)
47x Digital Electronics
48x Heating and Ventillation

V. TRANSPORTATION

50x	Auto Mechanics
51x	Small engines
52x	Air Vehicles
53x	Water Vehicles
54x	Non-fuel Vehicles
55x	Industrial Material Handling
56x	Mass Transportation

ANSWER	CAT	TOP	GR	NO	QUESTION
( )	430	460	12	445	The process of smothing out the output voltage of a rectifier circuit is called: a. filtering b. smoothing c. leveling d. grading.
( )	400	470	12	459	Which of the following is not considered one of the basic elements in an ADP system: a. input b. storage c. output d. amplifier?
( )	430	460	12	443	During the manufacture of most semiconductor devices, substances called impurities are added to semiconductor materials by a process called: a. addition b. injection c. fusing d. doping.
( )	410	460	12	457	The image-orthicon tube has the following basic parts: a. 2 b. 3 c. 4 d. 5.
( )	400	460	12	456	The standard intermediate frequency used in a superheterodyne is: a. 355 kHz b. 455 kHz c. 455 mHz d. 655 mHz
( )	400	450	12	440	The two electrodes in the basic thermionic converter are called the emitter and the: a. collector b. receiver c. antenna d. target.
( )	430	460	12	454	Feedback is the process by which information: a. is sent back to the information user b. can bbe verified by the information initator and modified when necessary c. can e decoded easily d. is received and transmitted again.
( )	430	450	12	439	The basic thermionic energy converter consists of two electrodes placed in a: a. liquid b. magnetic field c. gas d. vacuum.

1COMPREHENSION TEST

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ANSWER CAT TOP GR  NO   QUESTION
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(    ) 400 450 12  452  The unit on an electronic air cleaner which traps larger dust
                        particles is called a:
                        a. screen
                        b. pre-filter
                        c. grid
                        d. net.

(    ) 400 450 12  451  Voltages that cause currents to be present in the rotor assembly
                        of a split-phase motor are produced by electromagnetic:
                        a. deduction
                        b. transfer
                        c. induction
                        d. repulsion.

(    ) 410 450 12  435  The rotating (revolving) part of a large ac generator is ususlly
                        referred to as the:
                        a. rotator
                        b. rotor
                        c. wheel
                        d. spinner.

(    ) 410 450 12  449  One horsepower is equal to:
                        a. 646 watts
                        b. 746 watts
                        c. 764 watts
                        d. 784 watts.

(    ) 420 450 12  433  The small blocks of carbon which are in contact with the commutator
                        of a dc generator are called:
                        a. contacts
                        b. points
                        c. brushes
                        d. wipers.

(    ) 410 460 12  447  The devices commonly used for connecting shielded coaxial cables
                        to microphones, amplifiers, and certain test instruments are called microphone:
                        a. jacks
                        b. connectors
                        c. plugs
                        d. receptacles.

(    ) 400 450 12  434  The coil assembly that in some generators is rotated within a
                        magnetic field is called an:
                        a. energizer
                        b. exciter
                        c. assembly
                        d. armature.

(    ) 480 460 12  453  The person who starts the communication process is called the
                        information user.

(    ) 410 470 12  460  The purpose of an input device is to feed data into the system.

(    ) 490 460 12  458  Some color TV receivers have voltages as high as 27,500 volts
                        applied to the picture tube.
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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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 (    )  420 460 12  442  At ordinary room temperatures, a pure semiconductor material
                          is neither a good conductor nor a good insulator.

 (    )  430 460 12  444  The anode of a semiconductor diode is made up of n-type material.

 (    )  410 460 12  455  A device whose input is one form of energy and whose output
                          is another form of energy is called a transducer.

 (    )  400 460 12  446  A transistor symbol indicates whether the transistor is of the
                          n-p-n or p-n-p type.

 (    )  400 450 12  438  Electrical energy is one of the cleanest of all energy forms.

 (    )  420 450 12  437  A three-phase generator is equipped with three seperate sets
                          of windings.

 (    )  420 450 12  436  A magneto is direct-current generator.

 (    )  470 450 12  450  A typical motor cannot be damaged by overoiling.

 (    )  400 450 12  441  The cathode of an electron tube may be directly or indirectly
                          heated.

 (    )  410 460 12  448  Fahnestock clips are most often equipped with screw-type terminals.

 (    )  400 450 12  432  At the present time, all of the world's electric energy is
                          produced by generators.

 (    )  400 450 12  431  In a generator, the magnetic field may be stationary or it may be
                          rotated past stationary coils off wire.
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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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 (    )  120 150 09  430  One of the following hardwoods is not comparatively heavy:
                          a. yellow birch
                          b. sugar maple
                          c. American beech
                          d. basswood.

 (    )  120 150 09  429  The relative hardness of one of the following softwoods is high:
                          a. sugar pine
                          b. white fir
                          c. western white pine
                          d. western larch.

 (    )  120 150 09  428  The relative hardness of one of the following hardwoods is low:
                          a. black walnut
                          b. black cherry
                          c. white oak
                          d. cottonwood

 (    )  120 150 09  427  One of the following is not among things to be considered
                          in selecting fine furniture woods:
                          a. good appearance
                          b. attactive color
                          c. low cost
                          d. minimum warpage.

 (    )  120 150 09  425  One of the following is not a kind of authentic mahogany
                          a. African
                          b. Tropical American
                          c. Malayan
                          d. Cuban.

 (    )  120 150 09  424  Most western white pine lumber is used in building construction.

 (    )  120 150 09  423  One type of authentic mahogany is native to the Philippine Islands.

 (    )  120 150 09  422  One of the following is not a common softwood:
                          a. redwood
                          b. sitkaspruce
                          c. sweet gum
                          d. western red cedar.

 (    )  130 150 09  421  Hardboard and particle board are products which have
                          developed as a result of the process of:
                          a. abrading
                          b. turning
                          c. shearing
                          d. grinding.

 (    )  120 150 09  426  Most softwood plywoods are made from:
                          a. western hemlock
                          b. western larch
                          c. white fir
                          d. Douglas fir.
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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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 (    )  130 150 09  420  Abrading is not done in one of the following ways:
                          a. on a jointer
                          b. on a belt sander
                          c. by hand with sandpaper
                          d. on a disc sander.

 (    )  130 150 09  419  One of the following is not a common subassembly:
                          a. table top
                          b. chair back with rails
                          c. door set in a frame
                          d. window unit.

 (    )  130 150 09  418  Subassemblies are combined to make up the finished product.

 (    )  130 150 09  417  One of the following is not standard part:
                          a. table leg
                          b. chair arm
                          c. the turned rung of a chair
                          d. the three-legged base of a plant stand.

 (    )  140 150 09  416  One of the following is not a common regional style of home
                          in the United States:
                          a. Cape Cod
                          b. Western Modern
                          c. French Provincial
                          d. Colonial.

 (    )  140 150 09  415  WHEN SPEAKING OF COLOR, THE PATTERN OF CONTRAST IN LIGHT
                          REFLECTIONS IS KNOWN AS TEXTURE.

 (    )  190 150 09  414  A ladder should be secured at an angle of:
                          a. about 90 degrees
                          b. about 75 degrees
                          c. about 50 degrees
                          d. about 60 degrees

 (    )  190 150 09  413  To lift a heavy object you should use your back muscles,
                          not your leg muscles.

 (    )  190 150 09  412  All cutting operation on the circular saw can be done with
                          a basket-type guard in place.

 (    )  190 150 09  411  One of the following is an incorrect method of dressing
                          fot woodwork:
                          a. wear a short-sleeved shirt
                          b. tuck in your tie
                          c. roll up your tie
                          d. wear rings and other jewer
                          d. wear rings and other jewelry
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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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( ) 180 150 09 410 The following professional person spends a good deal of time out of doors:
a. industrial education teacher
b. interior designer
c. forester
d. research worker.

( ) 180 150 09 408 Those who make up the largest skilled trade group are the:
a. pattern-makers
b. cabinetmakers
c. painters and finishers
d. carpenters.

( ) 180 150 09 407 One of the following is not member of the construction industry team:
a. architect
b. contractor
c. funiture designer
d. carpenter

( ) 120 150 09 406 One of the following is not an important manufactured wood material:
a. plywood
b. hardboard
c. cokeboard
d. particle board.

( ) 180 150 09 409 Carpenters who do exterior and interior trim work are called:
a. rough carpenters
b. finish carpenters
c. skilled carpenters
d. millrights.

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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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 (    ) 510 510 11  243  In the power stroke of a four-stroke cycle engine,
                         a. the exhaust valve is open.
                         b. the intake valve is open.
                         c. both valves are open.
                         d. both valves are closed.

 (    ) 570 510 11  242  Carbon deposits should be removed from cylinders of an engine to
                         a. prevent overheating of the engine.
                         b. insure that valves open properly.
                         c. help keep tappets adjusted.
                         d. help maintain proper timing.

 (    ) 570 510 11  240  If an engine misses, it may be due to
                         a. worn timing gears.
                         b. low oil supply in the crankcase.
                         c. empty fuel tank.
                         d. burned or dirty valves.

 (    ) 540 510 11  239  Diesel engines have a compression ratio of
                         a. 15:1 to 18:1.
                         b. 4.5:1 to 7:1.
                         c. 5.1:1 to 6:1.
                         d. 3.5:1 to 4.5:1.

 (    ) 500 510 11  238  Before an engine can be timed, a piston must be as high as it
                         will go. When a piston is as high as it will go, it
                         a. is said to be at crank-end dead center.
                         b. is said to be at head-end dead center.
                         c. is said to be at the top of the power stroke.
                         d. is said to be at the top of the exhaust stroke.

 (    ) 570 510 11  236  If an engine fails to start, check first to determine whether
                         a. foreign material is in fuel tank.
                         b. fuel octane is adequate.
                         c. distributor is wet or dirty.
                         d. cylinders are carboned excessively.

 (    ) 570 510 11  235  If an engine runs but lacks power, it may be due to
                         a. inadequate oil circulation.
                         b. poor compression.
                         c. loose ignition wire.
                         d. slipping fan belt.

 (    ) 510 510 11  234  Thermostats are provided on the cooling system of a tractor to
                         a. provide proper temperature for effective engine operation
                         b. keep the water under 160 degrees Fahrenheit.
                         c. control the level of the water in the radiator.
                         d. control the temperature of the water.

 (    ) 520 510 11  233  Piston rings are used to
                         a. prevent knocking on the power stroke.
                         b. allow the use of lower grade fuels.
                         c. prevent the formation of carbon on the cylinder walls.
                         d. prevent gas leakage between the piston and the cylinder.
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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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 (    )  520 510 09  241  A high compression engine uses
                          a. high test kerosene for fuel.
                          b. high test gasoline for fuel.
                          c. high test distillate for fuel.
                          d. regular gasoline for fuel.

 (    )  530 510 11  232  Dirt removed from the air by the air cleaner on a tractor is
                          deposited
                          a. in the sediment bulb.
                          b. in the oil cylinder of the air cleaner.
                          c. in the oil cleaner
                          d. in the air-cleaner cup.

 (    )  530 510 11  231  On the intake stroke of a four-stroke cycle engine the
                          a. intake valve opens.
                          b. intake valve closes.
                          c. exhaust valve opens.
                          d. both valves are closed.

 (    )  530 510 11  230  In a two-stroke cycle engine , the crankshaft makes
                          a. one and one-half revolutions per cycle.
                          b. two revolutions per cycle.
                          c. one revolution per cycle.
                          d. four revolutions per cycle.

 (    )  530 510 11  229  The first step in timing a distributor is to turn the engine so.
                          a. number one piston is at top dead center of the compression stroke.
                          b. number one piston is at top dead center of the intake stroke.
                          c. number one piston is to top dead center of the exhaust stroke.
                          d. number one piston is at top dead center of the power stroke.

 (    )  530 510 11  228  If an engine is timed too slow, it will
                          a. run too rapidly.
                          b. knock.
                          c. be sluggish and lack pickup.
                          d. overheat.

 (    )  570 510 11  227  A compression tester may be used in diagnosing engine troubles
                          to determine whether
                          a. the spark plugs are dirty.
                          b. the mixture is too lean.
                          c. a faulty gasket is present.
                          d. the timing is properly adjusted.

 (    )  500 510 11  226  A diesel engine does not have a
                          a. power stroke.
                          b. fuel injector.
                          c. fuel pump.
                          d. carburetor.
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1COMPREHENSION TEST

 ANSWER CAT TOP GR  NO   QUESTION
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( ) 530 510 11 225 In an internal combustion engine, the pistons are fastened to connecting rods by
a. main bearings.
b. wrist pins.
c. piston rings.
d. several shims.

( ) 530 510 11 224 After the fuel is properly mixed in the carburetor, it is delivered to the cylinder through
a. a float valve air intake.
b. a manifold.
c. an air intake.
d. a carburetor.

( ) 530 510 11 222 To get best results from carburetors,
a. adjust idling speed every ten hours.
b. adjust before the engine warms up.
c. adjust each morning when going to the field.
d. do not adjust unless necessary.

( ) 520 510 11 221 The lubricating oil in the crankcase needs to be checked more frequently when
a. an engine runs hot.
b. an air cleaner is used.
c. the weather is warm.
d. high octane gasoline is used.

( ) 500 510 11 220 If the piston rings are not properly sealed by oil,
a. the valves will stick.
b. there will be a loss of power.
c. the cam-shaft bearing will wear rapidly.
d. the engine will overheat.

( ) 500 510 11 219 An important function of a carburetor is
a. to vaporize the fuel.
b. to pump liquid fuel to each cylinder.
c. to prevent the overheating of the engine.
d. to mix the lubricating oil and the fuel.

( ) 570 510 11 218 If an engine fires irregularly, it may be due to
a. governor sticking or controls bent.
b. fuel tank vent hole plugged.
c. excessive carbon deposits in cylinders.
d. intake valve stuck in open position.

( ) 570 510 11 217 When testing a battery with a battery hydrometer, it should read, at eighty degrees Fahrenheit,
a. between 1.250 and 1.295 if will charged.
b. between 1.105 and 1.245 if well charged.
c. between 0.960 and 1.100 if well charged.
d. between 0.915 and 0.955 if well charged.

( ) 510 510 11 213 A volt meter will measure the pressure of the electricity or force of the current.

1COMPREHENSION TEST

ANSWER	CAT	TOP	GR	NO	QUESTION
( )	330	310	10	157	For a given film and contact screen, identify the procedure for determining the basic flash exposure.
( )	320	320	10	151	Panchromatic film is not sensitive to a. green light b. blue light c. red light d. none of the above are correct
( )	330	320	10	150	A halftone screen with a 65 line classfication will produce a coarser reproduction than will a a. 50 line screen b. 133 line screen c. mezzo tint screen d. square dot screen
( )	330	310	10	149	Processing chemicals should be placed in order as follows, from left to right a. developer, fixer, stop bath, water b. developer, stop bath, fixer, water c. stop bath, develper, water, fixer d. fixer, developer, stop bath, water
( )	330	320	10	147	Photo-stencil film must be developed for ____ seconds a. 90 b. 200 c. 2 1/2 d. 30
( )	320	310	10	146	The optimal processing temperature for most photographic materials is a. 69 b. 67 c. 68 d. 65
( )	330	310	10	145	The higher the f-stop number, a. the larger the lens opening b. the greater the focal length of the lens c. the sharper the focus of the lens d. the smaller the lens opening
( )	300	310	10	144	Lines of type, preprinted type, photocomposition, hand lettering and clip art are all examples of a. line copy b. halftone copy c. negative copy d. camera-ready copy
( )	330	310	10	143	Applying a light-blocking liquid to the negative to cover pin holes is known as a. opaquing b. touching up c. blocking out d. blacking out

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1COMPREHENSION TEST

ANSWER CAT TOP GR  NO   QUESTION
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(    )  33  310 10  142  A precess negative should remain in the fixer
        ddd              a. four minutes
                         b. two to four days
                         c. twice the length of time required for the stop bath
                         d. twice the length of time required for exposing the image

(    )  350 330 10  139  Screen process printing was first usd by the
                         a. Greeks
                         b. Japanese
                         c. Germans
                         d. Chinese

(    )  330 300 10  136  Offset lithography is a type of planographic printing, since
                         a. a planer block is used to level foundry type
                         b. it is a production process which prints from a flat surface
                         c. the offset press uses a metal plate
                         d. the offset press has a rubber blanket

(    )  330 310 10  134  If you are given camera-ready copy which is 8" x 10" and told
                         to produce a negativ ewhich is approximately 5 1/2" x 7 1/2", you
                         should expose your negative at approximately
                         a. 75%
                         b. 65%
                         c. 81%
                         d. 132%

(    )  330 320 10  133  Orthochromatic film is not sensitive to
                         a. green light
                         b. blue light
                         c. red light
                         d. none of the above are correct

(    )  340 300 10  132  Halftone screens can be designated by
                         a. the shape of the halftone dot
                         b. the number of dots per linear inch
                         c. both a and b are correct
                         d. neither a nor b are correct

(    )  330 300 10  131  The procedure designed to prevent screen printing inks from
                         penetrating the fabric around the stencil is called
                         a. masking
                         b. using tape
                         c. papering
                         d. registration

(    )  340 300 10  130  ____ is the design element which refers to the overall
                         dimensions of the sheet.
                         a. contrast
                         b. rhythm
                         c. balance
                         d. proportion
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1COMPREHENSION TEST
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ANSWER	CAT	TOP	GR	NO	QUESTION
( )	310	300	10	129	The tool or instrument used to force the ink through the screen is called a a. spatula b. frame c. mesh pusher d. squeegee
( )	330	320	10	128	A positive image may be produced on ortho film by a. pre-deviloping the film prior to the initial white-light exposure b. contact printing from a positive c. contact printing from a negative d. normal exposure of the art work
( )	320	320	10	137	The two parts of sencil film are a. emulsion and backing b. polyethelene and backing c. plastic and mask d. backing and mask
( )	330	300	10	126	Screen stencils may be removed with a. ink b. varsol c. water d. lacquer
( )	340	300	10	122	The design element of ____ allows for the emphasis of selected portions of a printed message, and may be accomplished through the rise of color, shape, size or texture. a. rhythm b. proportion c. contrast d. none of the above
( )	300	310	10	121	A process camera's quality is most usually determined by its a. lighting system b. amount of automated features c. lens quality d. size capacity
( )	330	320	10	119	Developer for ortho film is made by mixing a. equal amounts of equally-diluted portions of A and B developers b. equal amounts of A and B developers c. equal amounts of A and B developer and the same amount of water d. twice as much A as B developer, and 4 times as much water as 1/2 of the amount of A-B mixture
( )	330	300	10	127	Perhaps the most versatile printing production process, due to its ability to print almost printing. a. offset b. letterpress c. gravure d. screen proces

1COMPREHENSION TEST

ANSWER	CAT	TOP	GR	NO	QUESTION
( )	290	220	10	405	The size of a 600-foot extension cord for a tool rated at 5 amperes is: a. #18 b. #16 c. #14 d. #6.
( )	290	220	10	404	An isolation-type ground-fault interrupter is sensitive enough to trip at the presence of: a. 0.5 mA b. 0.7 mA c. 1 mA d. 2 mA
( )	290	220	10	403	In normal operation, a grounding conductor cable has a green jacket.
( )	290	220	10	402	The U-blade confuguration is most widely used and us designated a 125-volt, 15-ampere, two-pole, three-wire grounding type.
( )	290	220	10	401	Fuses and circuit breakers can distinguish between fault current and normal load current.
( )	290	220	10	400	When meter housings are mounted outdoors, separate from the service equipment, the neutral wire in the meter should run to ground.
( )	290	220	10	396	Overcurrent devices do not have to be installed in every circuit to protect from overloads.
( )	290	220	10	395	The code states that solder should never be used for grounding connections.
( )	270	220	10	394	The kilowatt-hour meter measures power consumed by the day.
( )	270	220	10	393	If you want to control a light from three locations, you will need two three-way switches and one four-way switch.
( )	270	220	10	392	Many major appliances in the kitchen require individual equipment circuits.
( )	210	220	10	391	There are no present metric standards for electrical equipment.
( )	210	220	10	390	The thickness of wire is measured by inserting the wire into the wire gage hole.
( )	210	220	10	389	The standard wire gage is used to check the size of wire.
( )	290	220	10	388	A heart that is in fibrillation can be restricted by closed chest cardiac massage.
( )	290	220	10	387	To prevent sagging, an extension ladder should be stored vertically.
( )	290	220	10	386	To raise an extension-type ladder, walk forward under the ladder.

1COMPREHENSION TEST

ANSWER	CAT	TOP	GR	NO	QUESTION
( )	290	220	10	385	Splices cannot be made without boxes for the cord and cable runs with temporary wiring.
( )	290	220	10	384	Cord sets can be obtained with GFCI-protected plug-in units.
( )	290	220	10	383	The abbreviation GFCI stands for (on reght): a. Ground fault circuit interruper b. Ground fault circuit inspector c. Ground found circuit inspected d. Ground fault circuit imprement.
( )	290	220	10	382	Temporary electrical power and lighting installations shall be permitted during the construction, remodeling, or demodeling, or demolition of buildings.
( )	290	220	10	399	The Code says that receptacles can be mounted within ten feet of a swimming pool.
( )	290	220	10	397	The ground-fault interrupter operates only on line-to-ground fault currents.
( )	290	220	10	381	The National Electrical Code does not allow for temporary wiring.
( )	290	220	10	398	Sone GFIs may used in conjunction with underwater lights in swimming pools.

APPENDIX K

WORKSHOP PARTICIPANTS

HIGH SCHOOL INDUSTRIAL ARTS PROJECT WORKSHOP PARTICIPANTS

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Workshop Participants
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